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No. 98

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INTERACTION OF RETICULAR SHELL OF WHEEL AND GROUND SURFACE

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE
in Russian No 6, Jun 83 (manuscript received 26 Oct 82) pp 73-75

GRUSHIN, V. P., engineer, YEGOROV, A. I., engineer, and NAUMOV, V. N., candidate of technical science

[Abstract] Interaction of a reticular shell as tire on a wheel of lunar research vehicles (U.S. LRV's and Soviet "Lunokhody") and the ground surface was studied experimentally, from the standpoint of possible use of such wheels with a universal vehicle for ground transportation in the Far North, in sandy regions of Central Asia and Kazakhstan, and in swampy regions of Western Siberia. The tire, a toroidal shell, was made of elastic steel meshes: an outer one for traction and an inner one for shock absorption. The wheel dimensions were: outside diameter 530 mm, inside diameter 480 mm, width 210 mm. The test results reveal a low radial stiffness (15-35 N/m) and a high axial stiffness (100 N/m), the tangential stiffness being comparable with that of "Lunokhod-1" and "Lunokhod-2" wheels. Such a ratio of stiffnesses makes it feasible to widen the contact area between wheel and ground and thus improve the stability of motion. The tests were run on dry quartz sand simulating a deformable ground. The traction-slip characteristic of this experimental wheel on such a ground was measured, the results suggesting the possibility of improvement through optimization of the mesh design parameters to match the physico-mechanical properties of the ground material. This possibility was checked and confirmed by tests performed with rectangular stamped mesh blanks on sand. In these tests were measured horizontal displacement as function of the parallel pull force and depth of embedment as function of the vertical (normal) pressure force. Figures 3, references 3: 2 Russian, 1 Western.
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TRANSVERSE VIBRATIONS OF SHAFTLINE ON BOARD OF SHIP

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 270, No 6, Jun 83 (manuscript received 12 Jul 82) pp 1346-1350

KEL'ZON, A. S., ZOBNIN, A. P., MALININ, L. M. and TROSHKOV, Ye. I., Leningrad Higher Marine Engineering School imeni S. O. Makarov

[Abstract] Transverse vibrations of the shaftline in ships of the "Warnemunde" class are analyzed according to the spectral theory of stationary random functions, with the shaftline represented as a linear dynamic system. The input signal is a dynamic load on the propeller screw, and the output signals are vibrations of the shaftline. The solution to the corresponding equation of motion is based on the transient pulse response characteristic of the shaftline, with the spectral density of the random process assumed to be uniform over the passband. This response characteristic, determined experimentally, serves as the weight function here. Measurements for an experimental study were made in the "Pavlograd" steamship of the given class, displacement and acceleration transducers being placed along the shaftline in two planes and at various points of the ship hull as well as on the steering column, on the central control post, and on the rudder yoke. The shaft speed varied over the 80-130 rpm range (120 rpm = 2 Hz), the first critical corresponding to a natural frequency of 27 Hz. Oscillograms have yielded the frequency spectrum (2, 4, 8, 16, 31.5, 63 Hz). An evaluation of experimental and theoretical results indicates that turbulence in the water stream, which contributes a hydrodynamic component to the load, could be the cause of the higher-frequency (16-31.5 Hz) vibrations. The main source of transverse vibrations in this case is evidently not only the randomness of the sea waves profile but also and even more significantly the design-controlled interaction between water stream and propeller screw. Figures 2, table 1, references 4: 3 Russian, 1 Western.
[232-2415]

UDC: 621.313:537.312.62

UNIPOLAR SUPERCONDUCTING MACHINES FOR MARINE ELECTROMOTIVE SYSTEMS

Moscow ENERGETIKA I TRANSPORT in Russian No 1, Jan-Feb 83
(manuscript received 18 May 81; revised 31 Mar 82) pp 73-77

ANTONOV, Yu. F., BLOKHIN, Yu. V., DOMANSKAYA, Ye. Yu., KORSAKOVA, Ye. K., MAKSIMOVA, K. P., NOVITSKIY, V. G. and TRIPOL'NIKOVA, G. V., Leningrad

[Abstract] The construction of marine electric powerplants with power capacities of over 20 MW requires the use of superconducting unipolar machines. This article analyzes the possibility for creation and use of such unipolar machines on ships and states the tasks for further research in this area. A cross sectional diagram is presented of a 30 MW 160 rpm unipolar motor with both internal and external placement of the rotor. The calculations demonstrate the possibility in principle of manufacturing such motors. They can be created using structural and winding materials presently manufactured in the Soviet Union. The specific power ratings of unipolar motors and generators are less than those of collector machines of the same power rating. The efficiency of these machines is calculated as 96-97%, most losses occurring in the liquid metal contact and connecting strips. Losses can be decreased by effective design of contact units and increasing the dimensions of the machines. The machines would require a helium liquifaction plant with a capacity of approximately 50 liters per day. Figures 3, references 3: 2 Russian, 1 Western.
[252-6508]

UDC 621.039:658.26:697.328

AUTONOMOUS MANEUVERABLE LOW-POWER ATOMIC CENTRAL HEATING AND ELECTRIC POWER PLANT WITH HEAT STORAGE

Moscow ATOMNAYA ENERGIYA in Russian Vol 55, No 1, Jul 83
(manuscript received 10 Oct 82) pp 19-22

VORONKOV, M. Ye., GLYUZA, A. T., SERGEYEV, Yu. A., CHACHOVSKIY, V. M. and YAKOVLEV, V. V.

[Abstract] An autonomous maneuverable atomic central heating and electric power plant is described which contains two 14.7 MW (thermal power) reactors, each with steam generator and turbine, condenser, deaerator, and tap-water or hot-water tank for heat storage. The electric power is regulated by varying the steam rate at the turbine tap which feeds the central heating system. Auxiliaries include two feedpumps, two line pumps, and two storage pumps. Each boiler generates steam at 1.6 MPa, the two turbines are rated for 2.8 MW and 2.0 MW respectively. The central heating system operates with nominal and maximum steam rates of 9.4 and 16 t/h respectively, at a pressure of 0.18 MPa and a temperature of 114°C. An intermediate heat storing stage with steam-water heat exchanger can be added for extra-heavy duty. The performance curves indicate that, as the outdoor temperature rises from below -50°C to above +8°C, the heating power decreases linearly and the stored heat increases linearly during discharge, based on peak theoretical thermal power within a 24 h period. The tank utilization and the extra electric power required also depend on the ambient temperature. The cost effectiveness of using heat storage in rubles/yr decreases slightly with increasing unit cost of storage tanks in rubles/m^3 and increases appreciably with increasing cost of fossil fuel which nuclear fuel in this plant replaces. Figures 5, references 6 Russian.
[246-2415]

UDC 621.311.2:621.039.003

TECHNICAL AND ECONOMIC PREREQUISITES FOR CONSTRUCTION OF SPECIAL-PURPOSE ATOMIC CENTRAL HEATING AND ELECTRIC POWER PLANT

Moscow ATOMNAYA ENERGIYA in Russian Vol 55, No 1, Jul 83
(manuscript received 15 Jul 82) pp 14-18

BATUROV, B. B., BOLDYREV, V. M., LOSEV, V. L. and SIGAL, M. V.

[Abstract] The feasibility of combined heat and electric energy production with nuclear fuel depends on the size and the location of the plant as well as on ecological factors. Advantages of special-purpose atomic central heating and electric power plants must be borne out on the basis of their technical and economic indicators, relative to those of hybrid condensation-boiler atomic electric power plants already in existence. So far the VK-500 boiling-water reactor has proved itself well, and construction of a central heating and electric power plant with such a reactor has begun for installation in the Odessa metropolitan district, to service users within a 2-3 km range. Reasons for unsuitability of the VVER-1000 water-moderated water-cooled power reactor for this purpose are higher cost of operation with saturated steam, which also requires more cooling water, and the fact that it is designed for power plants containing four, six, or more generators, while district heating and electric power supply must be limited to and does not require more than two generator units. Other factors to be included in the evaluation are problems of land acquisition, namely the much higher value of urban and suburban real estate, problem of cooling towers versus pond-and-dam as source of cooling water, cooling towers being less efficient and a greater source of atmospheric pollution. With all these factors taken into consideration, guidelines are established here for a comparative cost effectiveness analysis of atomic central heating and electric power plants, with type K or type TK turbines, a special-purpose one and a first-generation general-purpose one, with city boilers, or city boilers and a plain atomic electric power plant covering peak loads. Figure 1, references 5: 4 Russian, 1 Western.
[246-2415]

UDC 621.039.526

PHYSICAL CHARACTERISTICS OF BN-600 FAST REACTORS

Moscow ATOMNAYA ENERGIYA in Russian Vol 55, No 1, Jul 83
(manuscript received 28 Dec 82) pp 9-14

KAZANSKIY, Yu. A., TROYANOV, M. F., MATVEYEV, V. I., YEVSEYEV, A. Ya., ZVONAREV, A. V., KIRYUSHIN, A. I., VASIL'YEV, B. A., BELOV, S. P., MATVEYENKO, I. P., KULABUKHOV, Yu. S., CHERNYY, V. A., DVUKHSHERSTNOV, V. G., BAKOV, A. T., IVANOV, A. P., TYUTYUNNIKOV, P. L. and PSHAKIN, G. M.

[Abstract] The BN-600 fast reactor, designed to deliver 600 MW of electric power, was built for the third unit in the Beloyarsk AES imeni I. V. Kurchatov. It operates on UO_2 fuel 21% enriched in the low-enrichment zone and 33% enriched in the high-enrichment zone. It features an integral construction of pumps and intermediate heat exchangers inside the reactor vessel, with three 3-loop cooling systems: one for each 200 MW generator. The neutron-physics characteristics of this reactor were studied prior to construction and installation, whereupon the reactor was tested for comparative evaluation of actual and theoretical performance. A special casette with Pu^{238}-Be ampules as triggering neutron source of $1.5 \cdot 10^9$ neutrons/s intensity was used for monitoring the chain reaction during loading and for determining the minimum critical mass. Calculated and measured was the reactivity margin, the reactor with a starting core and with sodium at a temperature of 225°C being in the critical state with the entire array of 18 shim rods (Eu_2O_3) almost completely inserted and the central shim rod (Eu_2O_3) as well as the two control rods (Eu_2O_3) and the six scram rods (B_4C 80% enriched) withdrawn. On the basis of these data have been determined the efficiency of each element in the regulation system, also the thermal effect (asymptotic temperature coefficient of reactivity), the barometric effect (increment of reactivity with increase of pressure), the hydrodynamic effect (decrement of reactivity with increase of pump speed), and the load effect (decrement of reactivity with increase of power level). The loss of reactivity due to fuel depletion was determined first with calibrating rods on the basis of their position at minimum measurable power levels and then with control rods on the basis of their displacement during long operating periods at constant power level. Last has been determined the energy distribution over the reactor volume. The results indicate the errors of theoretical calculations, all within 10-20%. Tables 5, references 7 Russian. [246-2415]

UDC 624.1.69+69.05+69.057

CURRENT CONSTRUCTION AND INSTALLATION OF ATOMIC ELECTRIC POWER PLANTS WITH VVER-1000 WATER-MODERATED WATER-COOLED POWER REACTORS

Moscow ATOMNAYA ENERGIYA in Russian Vol 55, No 1, Jul 83
(manuscript received 15 Nov 82) pp 3-9

SAPIR, I. L.

[Abstract] The program of AES construction and installation is based on organization and coordination of activities for maximum safety, reliability, and economy. The main four structural components are foundations, metal walls, containment housing, and fittings. Operations for building AES's with VVER-1000 MW reactors have been scheduled accordingly for sequential completion of four power units within an eleven-year period, with some inevitable and necessary overlap of preparatory and principal activities. According to rules of sound technological management, the operations are grouped into six lines: 1) design and layout of erection platforms, excavation of foundation pits for basic equipment, installation of engineering communication and traffic system; 2) construction of hydraulic equipment, including pumps and pipes; 3) erection of machine buildings with provisions for deaeration racks and electrical apparatus; 4) construction of nonhermetically enclosed lower compartment of reactor building; 5) construction of hermetically enclosed compartment of reactor building with containment shell inside; 6) construction of special-purpose wing as well as chemical water purification system and other auxiliaries. A peculiar feature of the general construction and installation program such as that pertaining to the Zaporozhye AES and the Balakovo AES with VVER-1000 reactors is crowding to a saturation point with underground traffic and communication networks for engineering and technological purposes, including roads for automobile and tracks for railroad transportation. This is an important factor in planning and scheduling of operations along the six lines. Erection of the reactor building involves rigging up for the housing construction and equipment installation, which requires and includes a 320 t bridge crane and a 400 t polar crane. The construction and installation program is designed for completion of each power unit within five years, with two-year intervals from one to the next. Figures 5, tables 4.
[246-2415]

UDC: 621.187.12

STANDARDS FOR WATER CONDITIONS IN HORIZONTAL STEAM GENERATORS OF VVER NUCLEAR POWERPLANTS

Moscow TEPLOENERGETIKA in Russian No 6, Jun 83 pp 49-55

MARGULOVA, T. Kh., doctor of technical sciences, MONAKHOV, A. S., TITOV, V. F., candidates of technical sciences, and SIRYAPINA, L. A., engineer, Moscow Power Engineering Institute, Gidropress Special Design Bureau

[Abstract] A study is made of standardization of water quality for operation of nuclear powerplant horizontal steam generators in water-cooled, water-moderated reactor systems. The following questions are studied: is it desirable to change the standards for water condition; are the latest approved standards satisfactory; what recommendations can be given for the creation of water standards most closely corresponding to the requirements of long-term operation of water-cooled, water-moderated nuclear powerplants. The water condition standards, both previously recommended, and suggested by the authors, are discussed one by one. Standards include content of dissolved oxygen, hardness, chlorides, silicic acid, iron, copper, zinc and oil content, as well as pH. Results of operation of water-cooled, water-moderated reactors indicate that leaks occur from the primary loop to the secondary. For this reason impurities are extracted in a closed cycle with purification on ion exchange filters. Leaks from the primary loop can be detected by measuring the specific activity of water in the steam generator. Recommended standards for steam generator water condition are presented in a table. The effects of the use of various structural materials in the reactor on heat engineering and water conditioning systems are discussed. Figures 2, references 23 Russian.
[250-6508]

UDC: 621.311.25:621.039

MANEUVERABILITY OF VVER REACTOR INSTALLATIONS

Moscow TEPLOENERGETIKA in Russian No 6, Jun 83 pp 7-8

YERMAKOV, N. I. and BIRYUKOV, G. I., engineers

[Abstract] An attempt is made to analyze problems arising during the use of a nuclear powerplant with a water-cooled, water-moderated (VVER) power reactor as power output is maneuvered, with possible plans for their solution. The sequence of studies of the maneuvering qualities of a reactor installation during planning is outlined. Plan calculations have shown that the VVER-1000 reactor has limited capacity for variation of output in the 50-100% of nominal range, resulting from specifics of the interaction of fuel with fuel elements cladding. No reliable solutions absolutely eliminating the possibility of damage to fuel elements under such conditions have yet been

found. Therefore, as these powerplants are operated limitations are imposed on the speed with which energy output can be increased after long term operation at low power levels, as well as the speed of return to nominal power levels after fuel elements are exchanged. Design and development of a core which would satisfy the requirements of use as semi-peak power units will require a large volume of complex and expensive research. The time has come to perform this research. References 5 Russian.
[250-6508]

UDC 662.997:662.93

HEAT LOSSES IN HOLLOW SOLAR RADIATION RECEIVER

Tashkent GELIOTEKHNIKA in Russian No 3, May-Jun 83
(manuscript received 8 Jun 82) pp 39-42

AVDEYEVA, L. V., SMIRNOV, S. I., TARNIZHEVSKIY, B. V. and
CHEBUN'KOVA, O. Yu., State Scientific Research Institute of Power
Engineering imeni G. M. Krzhizhanovskiy

[Abstract] The capacity of solar hot-water supply systems for various regions of the Soviet Union ranging from Central Asia to the Western border has been evaluated by the Beckman-Klein-Duffie method of f-charts, on the basis of data on the climate in 70 locations over a 10-year period. According to this method, the specific (per 1 m^2 area of solar radiation collector) annual heat production of a solar heating plant is a function of three collector characteristics, four locality characteristics, and three operating characteristics. Calculations were made for three variants of a plane solar radiation collector: 1) single glass pane with nonselective absorbing surface; 2) double glass pane with nonselective absorbing surface; 3) single glass pane with selective absorbing surface. A correlation of the results with the geographical latitude is poor, but it indicates that the specific annual heat production of such a plant is higher in the Asiatic part of the Soviet Union than in its European part. A correlation with the total annual input of solar radiation is much better and can be approximated with a linear relation, the slope and the intercept of the straight line being different for each type of collector. The results reveal, furthermore, that the specific annual heat production at any location decreases with increasing temperature of the hot water and with increasing annual load equivalence factor, the amount of fuel saved depending not only on the amount of solar heat utilized but also on the efficiency of the other energy source installed. Figures 3, table 1, references 4: 3 Russian, 1 Western.
[243-2415]

UDC 621.472

TESTS PERFORMED ON SOLAR RADIATION RECEIVER FOR SOLAR GAS-TURBINE PLANT AT REYNOLDS NUMBER 1500-4000

Tashkent GELIOTEKHNIKA in Russian No 3, May-Jun 83
(manuscript received 24 May 82) pp 32-34

DRABKIN, L. M. and KHATAMOV, P. U., Physico-Technical Institute imeni S. V. Starodubtsev, UzSSR Academy of Sciences

[Abstract] A compound solar radiation receiver for a gas-turbine plant was tested in air with laminar flow of the heat transfer agent, this device having been tested earlier with turbulent flow of the heat transfer agent. On the basis of these previous tests, its construction had been modified as follows. Its cylindrical segment was shortened by removal of five turns in the bottom (tail) part and a hollow cylinder was placed inside coaxially with both cylindrical and conical segments of the receiver so as to allow for a higher air flow rate at a hydraulic drag of the same magnitude as before. The inlet hole was covered with a glass hood. The performance was measured at a solar radiation density of 615-740 W/m^2 (mean thermal flux density in the focal spot 600 kW/m^2 with a concentration factor of 600-800) and an inlet temperature of 34°C, with the Reynolds number for the heat transfer agent varying from 1474 to 3876. Measurements included flow rate, outlet temperature, heat transfer to air, and pressure drop from inlet to outlet. The data are compared with those on turbulent flow of the heat transfer agent. The performance is seen to improve drastically as the pumping rate is increased to 0.01 kg/s and beyond. Figures 3, references 2 Russian.
[243-2415]

UDC 662.997:537.22(0.88.8)

EXPERIMENTAL STUDY OF PLANE SOLAR RADIATION COLLECTOR

Tashkent GELIOTEKHNIKA in Russian No 3, May-Jun 83
(manuscript received 14 Oct 82) pp 29-32

AZIMOV, S. A., KALANDAROV, B. and PIRMATOV, I. I., Physico-Technical Institute imeni S. V. Starodubtsev, UzSSR Academy of Sciences

[Abstract] An experimental method has been developed for determining the thermal characteristics of a plane solar radiation collector under natural conditions. The water heater was installed at a 45° inclination angle, water flowing into the test zone from an acceleration chamber at rather low velocity and under a constant pressure head with minimum perturbation. A layer of semitransparent material such as window glass, partly reflecting, partly absorbing, and partly transmitting incident light, was used as thermal insulation. Its transmission coefficient was measured as a function of time over a 24 h period. The performance of the heat transfer agent was also

measured, namely the dependence of its temperature on the length of the collector at a varying flow rate (0.008-0.00917 1/s) and under a varying radiation flux (611.8-727 W/cm^2) as well as at a constant flow rate (0.008 1/s) and a varying radiation flux (662-894.5 W/m^2). The results indicate that the capacity of a collector is approximately proportional to the length of the heat transfer channel, up to a saturation level reached because of water heater inefficiency. This was confirmed in a special experiment with two identical heat transfer channels in a hot box, one of them subsequently pulled out stepwise so that its effective length was thus stepwise decreased while the other one remained in place serving as a reference standard and the ratio of heat transfer agent flow rates was adjusted accordingly. The authors thank A. D. Ushakova for discussing the results. Figures 3, references 5 Russian.
[243-2415]

UDC: 621.311.21:62-525

STUDY OF "HIGH" PRESSURE AIR SYSTEM FOR CONVERSION OF HYDRAULIC UNITS TO SYNCHRONOUS COMPENSATOR MODE

Moscow GIDROTEKHNICHESKOYE STROITEL'STVO in Russian No 3, Mar 83 pp 11-14

SMIRNOV, A. M., engineer

[Abstract] The use of hydroelectric powerplant generators as synchronous compensators requires operation of the turbine without water, in most cases with compressed air. This achieves the minimum consumption of power from the network for rotation of the rotor. This use of hydraulic power units has increased. A transition has been made to the use of "high" pressure air, averaging 40 kgf/cm^2, to reduce the cost and size of air collectors required for the purpose. A general description of air systems used for this purpose is presented. Results are reported from testing of a system for conversion of hydraulic power units to synchronous compensator mode using two 75 cubic meter air collectors to drive 6 67 MW power units at air pressure 40 kgf/cm^2. The tests showed that a number of problems exist, primarily in the system of air lines used to feed the high pressure air to the turbines. The optimal parameters of the process of transition of the synchronous compensator mode are achieved at an air pressure of about 25 kgf/cm^2. When high pressure air is used the possibility of pneumatic hydraulic shock when the air is fed into the closed turbine cavity must be considered, with resultant possible damage to turbine bearings and covers. Figures 5, references 6 Russian.
[254-6508]

UDC: 621.313.12

HYDROGENERATORS WITH REMOVABLE ROTOR CASING

Moscow GIDROTEKHNICHESKOYE STROITEL'STVO in Russian, No 5, May 83 pp 13-14

VASIL'EV, B. N., LINYUCHEV, V. A. and FILATOV, N. A., engineers

[Abstract] The first experience in the use of removable rotor casing design in the USSR was obtained in the expansion of the Kegumskaya Hydroelectric powerplant on the Daugava River, where three 64 MW turbine units were installed in a new building. Preliminary calculations indicated that the use of the removable casing would be economically justified for installation of up to 6 units. These calculations considered the fact that the one-time savings achieved by reducing the load capacity of cranes would be compensated by some increase in cost of installation of each such unit. Tests proved the correctness of the calculations, and this turbine type was recommended for installation at the hydroelectric powerplant. The methods of installation of the stator are described. The design is found to be reliable and easy to install. Figure 1, references 2: 1 Russian, 1 Western.
[253-6508]

UDC: 621.313.322-81:'33.581

MODELING OF THERMOHYDRAULIC PROCESSES IN ROTATING CRYOSTATS OF CRYOTURBINE GENERATORS

Moscow ENERGETIKA I TRANSPORT in Russian No 1, Jan-Feb 83
(manuscript received 10 Dec 81) pp 155-160

RYBIN, Yu. L., STEPANOVICH, S. G. and FILIPPOV, I. F., Leningrad

[Abstract] The only possible means of increasing turbine generator power is increasing the induction in the gap between the rotor and stator. Superconductors offer the most promising means of creating the stronger magnetic fields. This article studies an evaporative system for cooling of rotating superconducting exciter windings. The distribution of pressure in the cooling system is analyzed beginning at the point where the steam leaves the rotor. Stable operation of the cooling system is determined primarily by the design of the unit which feeds helium to the outside of the cryostat. The necessary fluid level in the winding area is maintained by a strictly determined length of the radial channel. The thermal coupling between the radial channel and the cryostat zone reduces dynamic stability of the cooling system. Special measures must be taken to isolate the radial channel. The presence of thermal shunts of the radial channel does not facilitate equalizing the helium temperature over the length of the channel. The number of radial channels should be reduced to increase the flow speed of the helium and minimize nonadiabatic effects. Figures 5, references 6: 3 Russian, 3 Western.
[252-6508]

UDC 007.52:62-83

ANALYSIS OF REQUIREMENTS PLACED ON D.C. ELECTROMECHANICAL COMPONENTS OF INDUSTRIAL ROBOTS

Moscow ELEKTRICHESTVO in Russian No 2, Feb 83
(manuscript received 10 Sep 80) pp 1-8

KAZANSKIY, V. M., doctor of technical sciences, SABININ, Yu. A., doctor of technical sciences, MALININ, L. I., candidate of technical sciences, and PETROV, B. A., candidate of technical sciences

[Abstract] Manipulator operations of most modern industrial robots can be effected by drives ranging from 10 to 5000 W in size, subject to five basic constraints: maximum permissible displacement and velocity of the load carrying last kinematic link, its minimum acceptable acceleration, maximum permissible transient period during positioning and maximum permissible positioning error. A typical drive must produce monotonic movement without overregulation and must cope with variable static loads and their variable mechanical inertia as well as with variable mechanical stiffness of kinematic linkages, all this variability resulting in a proneness to oscillation. The performance of a drive is dictated by the space-time cycle of motion of the three members of the kinematic linkage: hand, forearm, arm. The guidelines for selection and design of servomechanisms consisting of a d.c. motor with speed-reducing gear and a closed feedback loop are based on several criteria, namely: minimum mass and size, minimum energy consumption, maximum response speed, and monotonic positioning. Monotonic movement is related to the damping characteristics and the conditions for full or adequate damping. Response speed and mass-size requirements are related to the inertia characteristics and the performance of low-inertia rotating components. The specification for a servomechanism according to these criteria and requirements are developed through analysis of equivalent electrical circuits and closed-loop control systems, with the mechanical mass-spring-damper system appropriately included. Low-inertia series and compound motors as well as separately excited ones are considered for this application, their performance characteristics and relative merits being comparatively evaluated here. Figures 6, tables 4, references 16: 15 Russian, 1 Western.
[244-2415]

UDC 621.921.02.(088.8)

DESIGN OF SECTIONAL GRINDING WHEELS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 5, May 83 (manuscript received 9 Apr 82) pp 143-147

GUSEV, V. G., candidate of technical sciences, docent, and SEROV, B. A., candidate of technical sciences, senior instructor

[Abstract] A sectional grinding wheel, with discontinuous cutting surface, is a metal disk with axial slots around the periphery into which abrasive segments have been inserted. It must be designed not only for standard performance characteristics such as mechanical strength at operating speeds and loads but also for shock and vibration resistance. Resonance must be avoided through the entire range of operating speeds, usually extending to 150% nominal rpm. The impact energy and the backlash must be calculated for rough finishing operation, under most severe conditions, and need not be calculated for the much less severe fine finishing operation. Design calculations must also include stability under periodic impacts during running as well as during starting, when not only normal but also tangential transient inertia forces act on the cutter segments. Figures 2.
[237-2415]

UDC 621.822.5

CHARACTERISTICS OF VERTICAL GAS BEARINGS WITH PROFILED SHAFT OR BUSHING SURFACE

Moscow MASHINOVEDENIYE in Russian No 4, Jul-Aug 83
(manuscript received 15 Nov 82) pp 101-106

KARPOV, V. S. and TIKHONENKOVA, O. N., Leningrad

[Abstract] The performance of vertical gas bearings is analyzed and their characteristics are determined in dimensionless form, considering a real situation where grooves forming a periodic profile have been cut on either the shaft surface or the bushing surface and taking into account possible resonance in the "shaft - lubricant film -bushing" system. The pressure in the bearing clearance is calculated from the solution to the corresponding Reynolds equation for the appropriate boundary conditions. The limit of bearing stability is established from the equation of motion for the shaft axis under static unbalance. With the critical mass of the shaft defined as that corresponding to resonance, its threshold mass after balancing and its threshold speed at the stability limit are determined accordingly. Numerical results are shown graphically for a shaft or a bushing with rectangular grooves, the surface profile being characterized by the relative groove depth and the coordinate of discontinuity in the lubricant film. The corresponding differential equations have been converted to an equivalent system of finite-difference equations and these have been solved numerically by the iteration

method with upper-bound relaxation. At the limit of infinite gas compressibility and zero shaft eccentricity this solution approaches the exact analytical one. The results reveal that, with the compressibility factor the same in each case, a bearing with profiled shaft is more stable under small perturbations than one with profiled bushing. They also suggest that stiffness of the bearing support cannot be used as criterion for evaluating the resonance and stability characteristics of such bearings. Figures 4, references 6 Russian.
[234-2415]

UDC 621.01

COUPLED MOVEMENTS OF ROBOT WITH TWO DEGREES OF FREEDOM AND ONE ENERGY SOURCE OF LIMITED POWER

Moscow MASHINOVEDENIYE in Russian No 4, Jul-Aug 83
(manuscript received 12 Mar 82, after completion 21 Mar 83) pp 48-54

LUNEV, V. V., Moscow

[Abstract] Under consideration is a robot with two degrees of freedom and only one limited-power energy source, the object being to analyze the dynamics of its coupled movements and to control them without excessive deviation from its natural (nominal) movements so as to minimize energy losses on control action. As the kinematic model serves a system analogous to the Versatran, a vertical column with moment of inertia J_0 rotating in two bearings about its axis with a horizontal guide hole through it at some height in which a heavy horizontal rod slides in two directions with masses m_C and m_D attached one at each end. This rod is set in motion by a rack-and-wheel mechanism. This mechanism and the rotating column are driven hydraulically or electrically. A hydraulic drive for this consists of a pump feeding two cylinders, one for rotation and one for reciprocation, the latter motion regulated by a distributor. Such a drive system includes also a reservoir for the working fluid with an overflow valve. An electric drive consists of an electric motor and a differential gear. The performance characteristics of both drives are analyzed on the basis of the equation of nonsteady holonomic coupling applicable here. The equations of motion for the robot arm, formulated as Lagrange equations of the second kind, are solved for starting and running conditions in the phase plane. The trajectory of the hand is determined on this basis, in a polar system of coordinates, and the sensitivity of their trajectory to changes in system parameters is evaluated for design purposes. Figures 5, references 4 Russian.
[234-2415]

UDC 681.7.023.73

GRINDING ASPHERICAL OPTICS IN MODERNIZED 'START-500' MACHINE TOOL WITH COMPUTERIZED CONTROL

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 6, Jun 83 (manuscript received 20 Oct 82) pp 35-37

TEVELEV, L. V. and TYUTEREV, B. V.

[Abstract] The machine tool "Start" produced in small series for precision grinding of optics with small asphericity (<30 μm) has been modernized by addition of automatic control for precision grinding of optics with larger asphericity (>100 μm) as well. A computer regulates directly the radial feed rate of the tool as well as its speed and the rake angle. For such a control, the cam mechanism through which the electric motor drives the tool has been replaced with a gear transmission, the pinion mounted on the motor shaft. The new "Start-500" is equipped with a thyristor-motor drive for moving the machine tool column, with three position indicators tracking the tool location relative to the axis of rotation and with an interface to an M-6000 control computer. The latter is supplemented with a discrete-data input module, an input/output device and a code-to-current converter. The machine tool can cut SO-115M and LK5 glass as well as pyroceramic blanks with diameters as large as 420 mm and asphericity as large as 253 μm, with precision within the 1-2 μm range. The machining time depends on the blank material and size as well as on the asphericity mode: typically 1.5 hours for a blank of pyroceramic 280 mm in diameter with a $y^2 = 1400x$ generatrix, 7 hours for a blank of SO-115M glass 260 mm in diameter with a $y^2 = 1028.856x + 4.80287x^2 + 0.039983x^3 + 0.00022057x^4$ generatrix. The "Start-500" tool represents an improvement in productivity and in precision of the asphericization process. Figures 2, table 1, references 3 Russian.
[227-2415]

UDC 681.3.06

SELECTION OF ROUTE FOR MACHINING EXTERNAL SURFACES ON MULTISPINDLE AUTOMATIC MACHINE TOOLS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 4, Apr 83 (manuscript received 24 Jun 82) pp 121-123

VOLKOV, O. Yu., engineer, KAZAKOV, V. A., candidate of technical sciences, and KAPUSTIN, N. M., doctor of technical sciences

[Abstract] A method is suggested for using a computer in the interactive mode to select the route for machining external cylindrical surfaces on multispindle automatic machine tools. The initial data for selecting the route are L--the length of the external cylindrical surface; z--the allowance;

t_{max}--the maximum cutting depth of the straight-turning tool; S^f_{max} and S^f_{min}--the maximum and minimum feed, respectively, for the forming tool; and S^{pr}_{max} and S^{pr}_{min}--the maximum and minimum feed, respectively, for the straight-turning tool. It has been demonstrated by analysis that the majority of cylindrical surfaces can be machined on multispindle automatic machine tools by using routes consisting of a maximum of three transfers. These include turning with the straight-turning tool, turning with the forming tool, and a combination of these. A comparison is made of possible variants of routes in terms of the number of turns of the spindle required for machining a specific surface. The most productive route is selected from these variants. With $t_{max} < z \leq 2t_{max}$ the following routes are possible: I--turning with straight-turning tool, turning with straight-turning tool; II--turning with forming tool; III--turning with forming tool, turning with forming tool. With S^{pr}_{sr} and S^f_{sr} representing the mean values of feeds recommended by the standards, variant I is used when $L/S^{pr}_{sr} \leq z/2S^f_{sr}$, II when $L/S^{pr}_{sr} > z/S^f_{sr}$, and III if $z/S^f_{sr} > L/S^{pr}_{sr} > z/2S^f_{sr}$. This is represented geometrically in the form of regions of applicability of routes as a function of L/S^{pr}_{sr}. A nomogram is presented for selecting the route as a function of z, t_{max}, L, S^{pr}_{sr} and S^f_{sr} for $z > 2t_{max}$. By employing this procedure it is possible to use a computer to reduce the number of variants of routes and to select the route without taking into account losses in changing tools and corrective adjustment. An example is given of applying the procedure to selecting the route for machining a part with three surfaces of different diameters. Figures 3, references 2 Russian.
[238-8831]

UDC 621.923.5 : 9,048.6

FUNDAMENTALS OF KINEMATICS AND DYNAMICS OF PROCESS OF ULTRASONIC EXTERNAL HONING

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 4, Apr 83 (manuscript received 3 Jun 82) pp 108-113

MARKOV, A. I., doctor of technical sciences, and YERMAK, P. A., candidate of technical sciences

[Abstract] The results are given of studies of the kinematics and dynamics of the process, newly developed by the authors, of ultrasonic diamond honing, whereby low-amplitude radial ultrasonic vibrations are imparted to a diamond hone utilizing a metallic bond. Studies were conducted by taking into account the probability of the participation of grains in cutting, a normal law of distribution of their height above the level of the bond, and a harmonic law of forced vibrations of the hone. A distinctive feature of ultrasonic diamond honing is the fact that ultrasonic vibrations are imparted to the diamond hone in the radial direction relative to the part being

treated; this is in addition to the working movements of the honing process. Under the effect of the pressing force, the vibrating hone cuts into the part with its most protruding grains to given depths and normal and tangential forces act on these grains. Two ultrasonic honing modes are possible: with continuous contact between the hone and part, when only part of the grains cut intermittently; and with intermittent contact, whereby all the grains of the hone cut intermittently. The intermittent-contact mode is preferred, since then the diamond hone once during a vibration cycle withdraws from the part by a certain distance and effective conditions are thereby created for the removal of sludge and penetration of cutting fluid into the cutting zone. Equations are derived for calculating the mean and maximum values of normal and tangential forces. With an increase in the amplitude of forced vibrations of the hone, conditions for the removal of sludge from the cutting zone are improved, and the hone's grains cut to a greater depth than with the presence of sludge in ordinary honing, and the productivity of the process is thereby improved. The radial and tangential forces of interaction of the diamond hone and part are increased with an increase in the cutting depth, the total number of grains in the working layer and the forces of microcutting by single grains, and are reduced with an increase in the root-mean-square deviation of the height of grains above the level of the bond and the roughness of the part being treated. The most projecting grains in the working layer of the hone absorb the maximum unit forces, which increase with an increase in the amplitude of forced vibrations of the hone, the mean pressing force and the scoring rate. Figures 3, references 2 Russian. [238-8831]

UDC 621.8.02

KINEMATIC ANALYSIS OF NEW WAVE-TYPE STEP-BY-STEP MECHANISM

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 4, Apr 83 (manuscript received 28 Apr 82) pp 25-29

DOBROLYUBOV, A. I., candidate of technical sciences, ZINKEVICH, V. I., docent, and SOKOLOVSKIY, A. V., docent

[Abstract] A description is given of a new general-purpose mechanism which employs flexible elements and converts the uniform rotary motion of the driving element into step-by-step rotary motion of the driven element. One step of the driven element is completed in one turn of the driving element. The angular step of the driven element equals $2\pi/K$, where K can be a whole number or fraction, and the mechanism can be of the gear or friction type. Two moving cylinders, 1 and 2, rotate around axes O_1 and O_2 respectively, and are surrounded by a flexible coupling. The cylinders can be smooth or have teeth on their side surfaces and the flexible coupling can accordingly be smooth or toothed. Axis O_2 of cylinder 2 is situated at the end of a carrier, which rotates independently of cylinder 1 around axis O_1. Two flexible links are attached to the flexible coupling, whereby each is attached at one end to a point on the continuous-loop flexible coupling and at the other to the body

of the mechanism. When the carrier rotates in one direction, cylinder 1 rotates in steps in the opposite direction; when the direction of the carrier is reversed, the motion of the driven element is reversed and the force is transmitted by one of the flexible links. Equations are presented for calculating the size of the angular step by which the driven cylinder is turned in one turn of the carrier for the case of a smooth flexible coupling and cylinders, and for the gear design. The equation of motion is derived for the driven element, as well as the velocity analog function for the driven element. It is shown that the driven element moves smoothly with maximum speed at the start and smooth reduction in speed to the completion of motion. Approximate formulas are presented for the equation of motion and velocity of the driven element for engineering calculations. This mechanism has a substantial reducing effect and does not require high-precision parts. In the example given, the angular step of the driven element is 0.488 rad with a gear ratio of 14. Figures 3.
[238-8831]

UDC 65.015.13

FEATURES OF TECHNOLOGICAL ASSURANCE FOR USE OF ROBOTIZED COMPLEX

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE
in Russian Vol 26, No 6, Jun 83 (manuscript received 18 Oct 82) pp 93-95

SOBOLEV, S. F., Leningrad Institute of Precision Mechanics and Optics

[Abstract] Robotization of a technological process can be effected at three levels of mechanization and automation: first level with one industrial robot operating one unit of technological equipment, second level with one industrial robot operating several units of technological equipment integrated into one process, and third level with one industrial robot operating several units of technological equipment of one type and thus a set of technological processes within a production segment. A robotized complex can be structured with either circular or linear zone of action. All other variants of robotized technological support are combinations of the three levels and the two structures, with a common interoperation transportation system. The performance of a robotized complex is evaluated in terms of the minimum base time $t_{0,min} = t_f + t_r$ (t_f - time necessary for feeding a blank part to a production tool, t_r - time necessary for removing a finished part from that production tool). When the actual base time is longer or shorter than the minimum, then respectively the industrial robot or the production tool idles. The optimum situation is $t_0 = t_{0,min}$, and the feasible number n of technological units in the complex can be determined from the ratio $n = t_0/t_{0,min}$. Manufacturability of parts by a robotized complex requires that they have uniformly shaped and located as well as clearly defined and oriented surfaces for gripping, with both blank and product designed for being held by the same manipulator tong. In batch production these requirements add time necessary for sorting and down time due to failure of any equipment to the piece processing time. Robotized technological support must, furthermore, provide for

adjustment of production tools to automatic operation and include means of process control as well as universal fixtures with automatic clamping and also automation of auxiliary operations such as chip removal. The computer plays an essential role here. Figure 1.
[225-2415]

UDC 620.178.3

EFFECTIVENESS OF DIAMOND BUFFING OF PARTS FOR GAS-TURBINE ENGINES

Kiev PROBLEMY PROCHNOSTI in Russian No 6, Jun 83
(manuscript received 22 Apr 80) pp 115-119

YATSENKO, V. K., Zaporozhye Institute of Machine Design

[Abstract] Diamond buffing is used as treatment of various GTE parts for improving their performance under cyclic load through equalization of stresses and strength. The effectiveness of this treatment has been evaluated on the basis of tests and extrapolation. As test specimens were used hollow cylindrical specimens of Kh12NMBF-Sh steel and 13Kh12N2V2MF-Sh steel as well as real turbine shafts made of 40KhN2MA-Sh steel. The object of the treatment was to produce favorable compressive stresses in plastically deformed surface layers on both the outside and the inside, rather than on either one of the sides only and consequently unfavorable tensile residual stresses on the other. Axial and tangential stresses in 7 mm wide longitudinal strips and in 45° arcuate segments cut from a shaft were measured with a PION-2 instrument, after a shaft 2 mm thick and 120 mm in diameter had been buffed with a spherical tool at a feed rate of 0.06 mm/rev with the part rotating at 200 rpm. Calculations for extrapolating the results were made according to the I.A. Birger formula. Fatigue tests were performed on cylindrical specimens 2 mm thick and 60 mm in diameter, mounted as cantilever beams in a UM-4 universal machine and loaded in plane flexure. The results indicate that buffing is more effective than polishing, that buffing of one surface only (outside or inside) reduces the fatigue limit, that the level of residual stresses can be regulated by varying the cycle and the sequence of cutting-buffing passes, and that the scale factor is not very significant as far as diminishing the effectiveness of buffing is concerned. The time factor has also been found to be insignificant, inasmuch as the physico-mechanical properties of specimens diamond buffed in 1968 were found to be practically the same ten years later. Furthermore, diamond buffing was also found to reduce the variance of the mean endurance limit to one half without shortening the mean life. Figures 3, tables 3, references 8 Russian.
[223-2415]

UDC 621.362:621.383.5

EXPERIMENTAL STUDY OF LOW-POWER STIRLING ENGINE

Tashkent GELIOTEKHNIKA in Russian No 3, May-Jun 83
(manuscript received 19 Apr 82) pp 19-24

MARKMAN, M. A., SHMATOK, Yu. I. and KRASOVSKIY, V. G., "Order of Labor's Red Banner" All-Union Scientific Research Institute of Current Sources

[Abstract] An experimental study of low-power Stirling engines was made, for the purpose of finding ways to increase their efficiency. The test object was a 200 W engine of the β-design modification, its piston and displacer driven by a slider-crank mechanism on ball bearings. Piston and drive were lubricated with fluid, the latter kept out of the working chamber by O-ring seals, the displacer was dry-lubricated and sealed with a Teflon ring. The cavities of the cold heat exchanger and of the regenerator were arranged to be coaxial with the cylinder, with cylinder and cold heat exchanger wrapped in a jacket with coils for water cooling and with regenerator thermally insulated, the tubular hot heat exchanger was heated with a gas burner. This construction ensured negligible heat leakage to the atmosphere. Losses of heat and mechanical power were measured in three tests: 1) engine at standstill with cylinder cover plate heated, heat lost by conduction through structural components only ($Q_L = 0.2T_c$ independent of mean pressure $1.0 < P < 22$ atm over the $20 < T_c < 500°C$ range); 2) engine with piston stationary in center position and displacer driven at 1440 rpm, cylinder cover temperature $T_c = 500°C$; 3) engine with displacer stationary and piston driven at 1440 rpm, working gas not heated. The results of these tests reveal that the main mechanical losses are caused by motion of the piston and the main heat losses are caused by nonideality of the regeneration process, these two components thus needing to be improved. Figures 5, references 3 Russian.
[243-2415]

UDC 531:539.3

THEORETICAL EVALUATION OF EFFECT OF ROTATION ON NATURAL FREQUENCIES OF TURBINE RUNNERS

Kiev PROBLEMY PROCHNOSTI in Russian No 6, Jun 83
(manuscript received 26 May 82) pp 98-101

IVANOV, V. P., Moscow, and YERMAKOV, A. I., Kuybyshev Institute of Aviation, Kuybyshev

[Abstract] Vibrations of a gas-turbine runner in a field of centrifugal forces are analyzed, with the conventional system of three differential equations describing the equilibrium of forces (shearing force, rotational and thermal forces) and moments (bending moment and twisting moment) on a disk element in polar coordinates modified. The rotational (centrifugal) force as well as the thermal (nonuniform heating) force are assumed to be invariant in time, namely constant in both magnitude and direction, always acting in a plane normal to the axis of rotation. Any other force or moment and displacement it produces are assumed to vary harmonically in time and space, with a complex amplitude and some order of symmetry. This formulation makes the reciprocity theorem for work applicable to a rotating disk (angular velocity $\omega > 0$), with the appropriate wave-dynamic stiffness and compliance matrices. This method of calculating the natural frequencies and evaluating the effect of rotation yields almost the results as the conventional method, but quite different results for disks with blades. The conventional method yields values for the natural frequencies which are too low, especially so in the latter case. Figures 4, references 6: 5 Russian, 1 Western.
[223-2415]

UDC 621.438.056

MORE COMPLETE FUEL COMBUSTION IN AIR HEATING CHAMBER WITH USE OF PREVAPORIZED FUEL

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA
in Russian No 1, Jan-Mar 83 (manuscript received 20 Apr 82) pp 102-103

MALISHEVSKAYA, N. A., CHUMACHENKO, V. G., GRUZDEV, V. N. and KUZNETSOV, I. Ye.

[Abstract] An air heating chamber for oepration with prevaporized fuel has been designed and built, then tested for completeness of combustion. Two fuel vaporization schemes were tried, with a helical tube containing the fuel placed in the stream of combustion products first at the outlet of a supplementary combustion chamber (temperature of combustion products 1000 K) and then at the outlet of the air heating chamber. The results indicate that fuel prevaporization improves the combustion process appreciably, bringing it near 99% completion, while the degree of its completeness in a combustion chamber with centrifugal injector decreases as the fuel mixture becomes

leaner. Both prevaporization schemes yield almost identical results, but use of a supplementary combustion chamber ensures a stable temperature and provides means of regulating it. Figures 3, reference 1 Russian.
[245-2415]

UDC 536.24

THERMAL STATE OF POROUS TURBINE BLADES IN STRAIGHT NOZZLE ARRAY

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 1, Jan-Mar 83 (manuscript received 25 Sep 81) pp 93-96

YEPIFANOV, V. M., ZOLOTOGOROV, M. S., NOSOVITSKIY, L. Sh. and PASHUTOV, A. V.

[Abstract] An experimental study was made of a straight gas-turbine nozzle array with air transpiration cooling of blades, for the purpose of determining the dependence of theme an temperature of the blade surface on the ratio of air flow rate to gas flow rate. The shell of the experimental center blade in an array of five was made of a 1 mm thick steel ornichrome wire mesh (wire diameter 90 μm) with 20-30% porosity welded to the ribs of a solid stem. The initial gas temperature did not exceed 980 K. The tests were performed in the static test stand at the Central Boiler and Turbine Institute imeni I. I. Polzunov, in 25 different operating modes for 30 hours. The data have then been evaluated according to the Bayley-Turner equation (AERONAUTICAL JOURNAL R.Ae.S. Vol 12, 1968), yielding the Nusselt number from the known Reynolds number at the perimeter of the inner channel and then the corresponding heat transfer coefficient. These relations made it possible to solve second-order differential equations describing the temperature field of plane and cylindrical walls with the aid of the Polyayev-Sukhov criterial relation for the "volume" heat transfer coefficient. The results are compared with those obtained by NASA (TMX-3248, 1975) with the initial gas temperature not exceeding 1040 K. Figures 3, references 8: 5 Russian, 3 Western.
[245-2415]

UDC 629.7.037.3

EXPERIMENTAL STUDY OF MODEL OF TURBOFAN-ENGINE EXHAUST DEVICE IN REVERSE-THRUST MODE

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 1, Jan-Mar 83 (manuscript received 12 Mar 82) pp 88-91

DAVYDOV, Ye. V., ZHUKOV, O. M., ZAGVOZDKINA, V. V., FISHBEYN, B. D. and TSYBIZOV, Yu. I.

[Abstract] The dependence of decompression and thrust reduction in the inner loop of a turbofan engine with mixing and reversing in the outer loop

on the geometry of the exhaust device was studied experimentally with two models of such a device. In the first model the afterturbine vent was conical with a 30° taper angle, in the second model a six-lobe mixing chamber was used for this purpose. The thrust was measured as a function of the available decompression ratio in the exhaust device, first without and then with the retainer of the outer loop in each case. Altogether six assemblies were tested, with the length of the vent varied from 73 to 273 mm and its diameters either 226/18. mm or 187/146 mm. A correlation of the data is possible only within very narrow ranges of values for each geometrical parameter involved, but some generalization of the results could be made necessary for design purposes. Figures 4, tables 2, references 4: 2 Russian, 2 Western.
[245-2415]

UDC 621.8.22

EXPERIMENTAL STUDY OF BALL BEARINGS COMBINED WITH HYDROSTATIC MOUNTING OF RUNNER IN GAS-TURBINE ENGINE

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 1, Jan-Mar 83 (manuscript received 22 Jan 82) pp 82-84

GORYUNOV, L. V., DEMIDOVICH, V. M., KLYUSHKIN, A. P. and YAKIMOV, N. A.

[Abstract] Mounting the runner of a gas turbine in a pair of ball bearings combined with a hydrostatic bearing will appreciably lengthen the life of the ball bearings when the product D·N of shaft diameter and shaft speed reaches high values, inasmuch as the inner race of each ball bearing rotates then at only a fraction of the shaft speed. The bearing life under these conditions is determined not so much by fatigue as by the operating temperature. A test stand has been built for testing the performance of ball bearings of various sizes in combination with a conical hydrostatic bearing, with complete oil-lubrication and air-cooling systems. The runner is driven by a d.c. motor through an elastic coupling and a speed multiplying gear set. Radial load is applied by weights hanging symmetrically from a rod through the housing. The axial load on each bearing can be varied from 0 to 5000 N, with the runner speed 15,000 rpm maximum and the temperature of the oil leaving a bearing allowed to rise from 30 to 80°C. The bearing housing is thermally insulated and mounted on another shaft rotating in auxiliary ball bearings. Instrumentation includes Chromel-Copel thermocouples, a scale with lever mechanism for torque measurements, a manometer and a piezometer. Figures 2, reference 1 Russian.
[245-2415]

UDC 621.438

EXPERIMENTAL STUDY OF THERMAL STATE OF TURBINE BLADES WITH PARTIAL-ROOT COOLING

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 1, Jan-Mar 83 (manuscript received 25 Feb 82) pp 64-66

ARKHIPOV, A. I., KUMYANTSEV, V. V. and LIPATOV, N. G.

[Abstract] An experimental study was made to evaluate the cooling of nozzle blades in high-temperature gas turbines at the root and at the periphery by means of annular air curtains. The tests were performed in an open wind tunnel, the gas stream from the combustion chamber entering the nozzle ring through an inlet tube and leaving it through an outlet tube, the air stream entering thenozzle ring separately from a forechamber through an orifice. The nozzle blades were of the thin-walled hollow airfoil type. The air flow rate was varied by varying the pressure at the inlet orifice. The temperature difference between gas stream and air stream was varied by varying the gas temperature and thus the boundary conditions for heat transfer on the gas side only. The results indicate a linear dependence of the cooling depth $\theta = (T_{g0} - T_{mb})/(T_{g0} - T_{a0})$ (T_{g0} - inlet gas temperature, T_{a0} - inlet air temperature, T_{mb} - mean integral blade temperature) on the relative air flow rate $\bar{G}_a = G_a/(G_a + G_g)$ (G_a - actual air flow rate, G_g - actual gas flow rate), the temperature factor being much less significant, at the blade root and center section within the ranges of $\bar{G}_a = 0.04$-0.20 and of $\bar{T}_{a0} = T_{a0}/T_{g0} = 0.7$-$0.4$ at $\bar{G}_a$ = const. One may expect deeper cooling at the periphery of blades by means of a similar air curtain and deeper cooling at the center section of solid blades. Figures 4, references 3 Russian.
[245-2415]

UDC 621.45:621.438

DIAGNOSIS OF STATE OF GAS-TURBINE ENGINE ON BASIS OF MODELS DESCRIBING DYNAMICS OF CHANGES IN MEASURABLE PARAMETERS

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 1, Jan-Mar 83 (manuscript received 23 Nov 81) pp 38-41

KONYUKHOV, B. M., AKHMEDZYANOV, A. M., SHPILEVSKIY, E. K. and SHEPEL', V. T.

[Abstract] Identification models in real time are constructed for diagnosis of gas-turbine engines, models which describe the dynamics of changes in parameters from normal to faulty state. Each model describing a process is referred to a class and the identification problem is reduced to classification of continuously taken readings, generally on the basis of any particular statistics and criteria. As the most expedient criterion, especially in the absence of a priori information, is selected that of the ideal observer

minimizing the probability of classification error. Autoregression models are the simplest as well as the most accurate and reliable ones for this application, usable even when the physical mechanism of a fault or failure is not quite understood. The parameters of such a model are best estimated by the Bayes method, with recurrence relations used for obtaining the estimates in the form of mathematical expectation. Classification of the states of an air raft engine requires, accordingly, a preselection of parameters adequate for analysis of hypothetical faults and a selection of adequate models of processes in the engine, separation of models of processes associated with faulty operation from those of processes associated with normal operation being necessary for this purpose. The last step is calculating the parameters of an identification model, after its order has also been appropriately selected. The entire procedure is demonstrated here on the diagnosis of a multistage axial compressor in three states: stable operation (class 1 processes), surging separation flow (class 2 processes), surge (class 3 processes). The postcompressor pressure is the measurable parameter in each state, and a fourth-order autoregression model is selected for adaptive diagnosis of all three states in succession. Figures 5, references 5 Russian. [245-2415]

UDC 621.438

CHARACTERISTICS OF 'SHORT' HYDRODYNAMIC DAMPERS ON ROTORS OF AIRCRAFT ENGINES WITH TURBULIZATION OF WORKING FLUID IN DAMPER CLEARANCE

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 1, Jan-Mar 83 (manuscript received 7 Dec 81) pp 20-23

BELOUSOV, A. I., RAVIKOVICH, Yu. A. and BALYAKIN, V. B.

[Abstract] A hydrodynamic damper on the rotor of an aircraft engine is considered without sealing at the clearance boundaries, such dampers being characterized as "short" ones. The effect of turbulization of the working fluid in the clearance on the dynamic characteristics of such a damper with compressible film of lubricant is evaluated, assuming a steady motion of the vibrator. The pressure distribution in the damper clearance is calculated on the basis of the equation $\frac{d}{dz}\left(\frac{\delta^3}{K_z}\frac{dp}{dz}\right) = 12\,\mu\delta_0\varepsilon\Omega\sin\varphi$ (p- pressure, δ_0- radical clearance with vibrator in concentric position, $\varepsilon = e/\delta_0$- relative eccentricity, e- absolute radial eccentricity, μ- dynamic viscosity, Ω- angular velocity of center-to-center line, z- axial coordinate, φ- angular coordinate, $K_z = 1$ for laminar flow and $K_z = (N_R/N_R^*)^{3/4}$ for turbulent flow, N_R- local Reynolds number, $N_R^*=2038$ critical Reynolds number). The effect of lubricant feed pressure on the boundary conditions is disregarded. Both radial and circumferential components of the hydrodynamic force which a fully turbulized lubricant film produces in the damper are calculated by integrating the pressure distribution function over two cores of turbulence

within a laminar subregion. A numerical example indicates that disregarding the turbulization of the lubricant can result in a 25% error in the evaluation of damper performance for design purposes. Figures 3, references 6: 4 Russian, 2 Western.
[245-2415]

UDC 629.78.036.22.001.63

PARAMETERS DETERMINING MAXIMUM THRUST OF RAMJET ENGINE

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 1, Jan-Mar 83 (manuscript received 15 Jun 81) pp 12-16

BAZHANOV, V. I. and STEPCHKOV, A. A.

[Abstract] The condition for maximum thrust of a ramjet engine, namely that the pressure at the nozzle throat be equal to the ambient pressure, is derived from the general expression for thrust. This condition is restated in terms of gas dynamic and thermodynamic relations, with the system of corresponding equations of motion found to require an additional constraint for closure. The relation between heat intake and work of friction, involving an empirical proportionality factor $0 < n < 20$ provides such a constraint applicable specifically to the equation of action reversal for supersonic flow in cylindrical or diverging conical combustion chambers. Subsequent analysis is based on assuming that fuel admission takes place at the chamber entrance only and the combustion process ends at the chamber exist only, that the momentum of the fuel stream does not influence the momentum of the air stream, and that heat transfer to and from the wal's occurs throughout the entire length of the combustion chamber, this heat being expressed in fractions of the work of friction between gas and nozzle walls. The parameters of air and fuel stream through the combustion chamber, and then the power losses, are calculated on this basis with their radial profiles assumed to be uniform and the gas assumed to be ideal ($k = 1.33$). The resulting expressions yield the engine thrust as function of various design variables, at given boundary conditions, and the optimum values of these variables as functions of the flight Mach number. Figures 3, references 7 Russian.
[245-2415]

UDC: 621.165

IMPROVEMENT OF DESIGN AND OPERATING RESULTS OF POWER TURBINE INSTALLATIONS BY MATHEMATICAL MODELING METHODS

Moscow ENERGETIKA I TRANSPORT in Russian No 1, Jan-Feb 83
(manuscript received 14 Jan 82) pp 141-149

SHUBENKO-SHUBIN, L. A., Khar'kov

[Abstract] A discussion is presented of problems of the formulation of mathematical models of the functioning of certain power turbine installation subsystems. The subsystems used were selected because of the desire to analyze the most representative systems and to show the possibility of using the same approaches to achieve optimal plan decisions and also to improve operating characteristics. The systems approach to planning is used to construct a hierarchy of mathematical models allowing effective mathematical experiments to be performed on modern computers considering all the specifics of functioning of the object, allowing directed search for the best design decisions and operating conditions. The algorithms and programs which have been created should be developed for each specific unit of the system, allowing analysis of the process of maneuvering for further improvement of the operating results of installations. The method developed can be implemented quite effectively in the practice of operating machines already on line, requiring very slight design refinements and improvement of the processes of loading and unloading of installations. Figures 3, references 15 (Russian). [252-6508]

UDC: 621.43.4.001.24

MEANS FOR INCREASING ECONOMY OF PISTON INTERNAL COMBUSTION ENGINES

Moscow ENERGETIKA I TRANSPORT in Russian No 1, Jan-Feb 83
(manuscript received 22 Apr 82) pp 100-105

KRUGLOV, M. G., Moscow

[Abstract] Internal combustion engines consume over half of the petroleum produced in the USSR as fuel. This indicates the importance of improving motor fuel economy. Some 30% of the total heat liberated in combustion in such an engine is lost to the surrounding environment. The question of creation of an adiabatic engine, i.e., one with no heat exchange with the environment, is therefore an important one. Calculations and the first experiments indicate that an adiabatic engine could be 20 to 25% more efficient than present internal combustion engines. The exhaust gases of the adiabatic engine could also be used to drive a turbocharging turbine, power turbine, and/or boiler for a steam turbine. Still more efficient is a freon turbine to utilize the heat of the exhaust gases. The use of refining methods such as vacuum distillation, hydrocracking and catalytic cracking can

also increase the yield of light and middle distillates from petroleum to more than 80% instead of the present 60%. Increased fuel yields from petroleum in combination with more efficient engines could partially relieve the fuel expense and shortage problem.
[252-6508]

UDC: 531.383

DETERMINATION OF TRANSFER FUNCTIONS OF DYNAMICALLY TUNABLE GYROSCOPE

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 19, No 4, Apr 83
(manuscript received 18 Feb 81) pp 95-101

ZBRUTSKIY, A. V. and SLYUSAR', V. M., Kiev Polytechnical Institute

[Abstract] Transfer functions are determined for single and multiple Cardan dynamically tunable gyroscopes in a nonrotating system of coordinates considering the specifics of their dynamics throughout the entire frequency band. The transfer functions of the gyroscope obtained from analysis of the exact equations of motion reflect its dynamic properties throughout the entire frequency band and allow a study of the dynamics and accuracy of stabilization systems based on the gyroscopes considering design specifics of sensing elements. References 3: 2 Russian, 1 Western.
[241-6508]

UDC 531.383

COURSE OF VEHICLE WITH CONSIDERATION OF ROLL AND TRIM

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE
in Russian Vol 26, No 6, Jun 83 (manuscript received 20 Oct 82) pp 64-67

DANILOVICH, L. N., Sevastopol

[Abstract] The course of an object moving with roll and trim can be calculated exactly from the solution to the system of trigonometric equations relating the azimuth of the object to the declination of the gyroscope wheel and both to the given parameters (roll and trim) as well as to the gyroscope mounting angle and the inclination of its principal axis. An exact solution by the numerical method of iteration is difficult and tedious. An approximate method of second-order accuracy has been proposed by A. Yu. Ishlinskiy (ORIENTATION - GYROSCOPES - AND INERTIAL NAVIGATION, Izd-vo Nauka, 1976). Here an exact analytical solution is obtained in explicit form with trigonometric and inverse trigonometric functions of the independent variables. Figure 1, references 2 Russian.
[225-2415]

UDC 621.373:535

ERROR OF TRIAXIAL SET OF LASER GYROSCOPES WITH COMMON INITIAL BIAS

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE
in Russian Vol 26, No 6, Jun 83 (manuscript received 5 Jul 81) pp 54-59

BRYKOV, V. G. and MOCHALOV, A. V., Leningrad Institute of Electrical Engineering imeni V. I. Ul'yanov

[Abstract] When a triaxial rigid set of three laser gyroscopes is mounted on a platform which rotates at constant angular velocity relative to the orientation of the gyro set about an axis which does not coincide with any of the three X,Y,Z instrument axes, then rotation of the platform produces an initial bias in all three gyroscopes. This bias is the same for all three gyroscopes when the OXYZ trihedron forms one 60° angle and one 45° angle with the corresponding coordinate axes fixed relative to the platform. The angular velocity of the gyro set is related to that of the object through matrices of direction cosines for the platform angle and the two trihedron angles. An explication of these matrices yields three equations for the projections of the angular velocity of the gyro set onto the three respective instrument axes. Further calculations by the variational method yield the error of gyroscope readings caused by the initial bias. Two configurations of the gyro set are considered. In one configuration, used for determining the angular coordinates of an object by the interference method, the error is largest in determination of one of the velocity components. In the other configuration, on a vibration stand with the gyro set performing small harmonic or quasi-harmonic oscillations about the plastform axis, the errors are equal in determination of all three velocity components.
Figures 2, references 4 Russian.
[225-2415]

UDC: 517.97:621.396.677.833.2

COMPENSATION OF MIRROR SYSTEM DEFORMATIONS IN RADIO TELESCOPES BY SECONDARY REFLECTOR CONTROL

Baku IZVESTIYA AKADEMII NAUK AZERBAYDZHANSKOY SSR: SERIYA FIZIKO-TEKHNICHESKIKH I MATEMATICHESKIKH NAUK in Russian No 6, Jun 82 (manuscript received 5 Jan 82) pp 105-109

GASANOV, E. E., VAYNBRAND, M. M. and KARASIK, B. G., Institute of Cibernetics

[Abstract] The method of optimal control of the secondary reflector is suggested as a means for compensation of phase and amplitude errors resulting from gravitational, wind and thermal deformations of the surfaces of large radio telescope reflectors. The method was implemented for a Gregory 2-reflector antenna with a main reflector aperture of 70-100 m. Optimization was based on achievement of the minimum phase error and on the condition of maximum efficiency. Both approaches involve two-stage methods. In the first stage data are generated and processed describing the deformation of the reflector system. In the second stage, optimization is performed. It is decided that it is desirable to use both of the methods simultaneously: approach with the geometric criterion to produce initial results, then the second method for their refinement. References 7: 4 Russian, 3 Western.
[242-6508]

UDC 681.335(088.8)

TWO-COORDINATE DEVICE FOR DEFLECTION OF LIGHT BEAM

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 6, Jun 83 (manuscript received 7 May 82) pp 58-59

EMDIN, V. S.

[Abstract] A hologram synthesized on the lateral mirror surface of a rotating cylindrical drum is considered as a device for deflecting a light

beam horizontally along a line and vertically across a frame. The hologram consists of adjacent vertical panels of variable-period sinusoidal diffraction gratings. Varying the period from one edge of a panel to the other facilitates horizontal deflection of the light beam through rather wide angles and varying the orientation of grating lines in each panel facilitates vertical deflection of the light beam. The equipment includes a laser beam, a light splitter (semitransparent) mirror and a plain mirror, a collimator and a microobjective forming respectively a plane-wave light beam and a spherical-wave light beam. Both light beams impinge on the holographic drum surface, after passing through a window in an opaque drum enclosure. An advantage of this device is that it does not require external synchronization of line sweep and frame sweep, synchronization having already been built into the hologram. Figures 3, references 4 Russian.
[227-2415]

UDC 535.24 : 621.3.08

OPTICAL SENSOR OF ANGULAR VIBRATIONS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 4, Apr 83 (manuscript received 1 Sep 82) pp 41-44

GENKIN, D. A., engineer, and PALOCHKIN, S. V., graduate student

[Abstract] A description is given of an optical sensor of angular vibrations for use on a special test stand for experimental investigation of dissipation of the energy of tangential elastic contact vibrations of plane butt joints. Vibrations are recorded by employing the photometric pinciple of recording and converting by means of a position-sensitive photodetector into an electrical signal the deflection of a light beam reflected from a mirror which vibrates together with the object under study. The beam from a type LG-78 laser is transmitted by means of a directing mirror to a mirror fastened to a lever constituting an element of the stand and whose angular vibrations it is the objective to record. The light beam is reflected repeatedly from the mirror vibrating with the lever by means of a fixed mirror above this mirror. The combination of a moving and fixed mirror forms an optical multiplier of the angular displacement of the reflected light beam, whose operating principle is based on the law of equality of the angles of incidence and reflection. If the moving mirror is turned by a certain angle α, the light beam exiting from the multiplier is turned from the initial position in the same direction by an angle of $m\alpha$, where m is the number of reflections of the light beam as it passes through the multiplier. The value of m can be varied over a wide range by using the directing mirror to change the angle of entry of the beam into the multiplier and the distance between the fixed and moving mirrors; thus, the sensor can be adapted to each specific experimental series. The beam is directed from the vibrating mirror to the photodetector through a screen which covers half the beam's cross section in the initial position. This arrangement enables good positional sensitivity combined with sufficient linearity when using an FD9E111A photodiode with a built-in lens as the

photodetector and if the photodetector operates in the linear section of the energy characteristic. The photodetector's signals are amplified in an amplifier with a low-impedance input stage. Since the resolution of the sensor depends on the stability of the intensity of the laser's emission, the LG-78's power supply was replaced with a power supply of the SBP-5 type for an LG-32 laser, reducing fluctuations in emission level by almost an order of magnitude. Measurements can be made in the region of narrow angles with an acceptable signal-to-noise ratio with m > 8. A cathode-ray oscilloscope is used to monitor the sensor's operation when adjusting for a specific experimental series, and an N117 loop oscilloscope is used to record angular vibrations. An oscillogram is presented for damping of tangential vibrations of a steel-to-steel butt joint under normal compression pressure of 2 MPa. Figures 3, references 4 Russian.
[238-8831]

UDC 662.997:537.22

HOLOGRAPHIC METHODS OF CHECKING IMPRECISION OF OPTICAL SURFACES IN MIRROR-TYPE RADIATION CONCENTRATOR ARRAYS

Tashkent GELIOTEKHNIKA in Russian No 3, May-Jun 83
(manuscript received 3 May 82) pp 25-29

ABDURAKHMANOV, A., ZAKHIDOV, R. A., IKRANOV, A. M., RAKHIMOV, D. A. and KHAYDAROV, A. V., Central Design-Engineering and Technological Office of Scientific Instrument Design, UzSSR Academy of Sciences

[Abstract] Two holographic methods of checking roughness and curvature errors on optical surfaces are considered for inspection of mirror-type radiation concentrator arrays. In the two-frequency method one records two holograms of the same object at two near frequencies on the same photographic film and uses radiation at one frequency only for their reconstruction so that two virtual images of the object are obtained of slightly different sizes and slightly shifted in space. They produce an interference pattern from which distortions can be determined. An argon-ion laser is a convenient light source, emitting at two close wavelengths (0.4642 and 0.4758 μm), the hologram does not have to be positioned precisely. The immersion method is used with a one-frequency laser. Here one places the object in a cell which is first filled with a transparent liquid or gas (refractive index n_1) for exposing the hologram and then with another substance (refractive index n_2) for exposing the hologram again. The final hologram is reconstructed with the reference light beam, a shift being ensured by the difference of refractive indexes $n_2 - n_1$ so that the object can be seen with its relief contour. Both methods are applicable to spherical as well as paraboloidal and hyperboloidal surfaces. The immersion method was tested on concave concentrator mirrors, using aqueous solutions of ethyl alcohol ($n_1 = 1.34$, $n_2 = 1.35$) and "Mikrat-LOI-2" photographic film with an LG-38 laser ($\lambda = 0.63$ μm) and a cubical light beam splitter. The holographic equipment was mounted carefully,

with suppression of low-frequency and high-frequency noise and vibrations. Parallelism of object beam and reference beam prevented lateral displacements and rotation as well as any shifts other than along the observation line. Surface imperfections due to roughness and curvature errors due to manufacturing imprecision of the order of 1 μm can be revealed by holographic inspection in such a manner. Figures 5, references 7: 3 Russian, 4 Western.
[243-2415]

UDC 621.039:621.375:621.3.038:533.92:539.3

THERMOPHYSICS OF FOCUSING MIRRORS FOR LASER-TYPE FUSION REACTORS

Moscow ATOMNAYA ENERGIYA in Russian Vol 55, No 1, Jul 83
(manuscript received 6 Aug 82) pp 37-42

SUBOTIN, V. I., GRISHUNIN, P. A. and KHARITONOV, V. V.

[Abstract] Focusing mirrors for laser-type fusion reactors must meet very stringent requirements, namely must facilitate reflection of high-intensity laser radiation within the 0.2-2.0 μm range of wavelengths, 0.3-3.0 MJ range of pulse energy, 0.1-10 ns range of pulse duration, and 1-100 Hz range of pulse repetition rate. The thermophysical characteristics of the mirror material and the mirror geometry determine its heating, the basic relation between temperature rise and incident energy being established first for a single laser pulse and then for periodically repeating laser pulses. From this standpoint are evaluated various multilayer coatings optically suitable for this application. Into consideration are taken dynamic effects and their impact on permissible radiation loads. Particularly important are mechanical and thermal stresses in the crystal lattice, and overheating of conduction electrons with attendant reduction of these stresses but also of the reflectivity and with greater likelihood of a breakdown of gases at the mirror surface. Similarly must be and have been evaluated the heating and deformation of a mirror by pulses of X-radiation and by neutrons. Knowing the mirror characteristics and the destructive effects of fusion products (rays, particles) on a focusing mirror, one can provide the necessary protection. The most effective method of protection appears to be placing the focusing optics as far as possible from the detonation chamber, especially when short-wave lasers are used. In a typical protective system mirror and target are separated by a muffler and a blanket in a tube filled with shielding gas. Figures 4, references 19: 9 Russian, 10 Western.
[246-2415]

UDC 621.375.8

SIMPLE ELECTRIC-DISCHARGE LASER EMITTING IN ULTRAVIOLET, VISIBLE AND INFRARED REGIONS OF SPECTRUM

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 3, May-Jun 83 (manuscript received 26 Dec 81) pp 164-165

GAMZATOV, N. M., KONYASHCHENKO, A. V., ORAYEVSKIY, A. N. and STARODUBTSEV, N. F., Institute of Physics, USSR Academy of Sciences, Moscow

[Abstract] An electric-discharge laser structure has been designed with means of ultraviolet preionization for emission of light at wavelengths ranging from 193.3 μm (with ArF* lasing molecule) to 10.6 μm (with CO_2 lasing molecule). The discharge tube is made of stainless steel, 80 cm long with 7 mm thick walls to an outside diameter of 17 cm. The anode and the cathode, each a rod 62 cm long and 20 mm in diameter, are both made of Duralumin and are inserted into the tube through windows and center holes in corresponding flanges. The interelectrode gap is 20 mm wide. Preionization is effected by a spark discharger (16 electrodes on one side and 15 electrodes on the other side of the main discharge) between sharp edges of its electrodes and auxiliary pins screwed into a face plate. Main discharge is produced by transfer from a 0.1 μF - 50 kV storing capacitor to a bank of thirty 1000 pF - 40 kV noninductive capacitors. Various dielectric plates are used as exit mirrors in the resonator for operation with HF (2700 nm), CO (5000 nm), CO_2 (10.6 μm) molecules. An ArF* (193.3 nm) molecule yields the least number of emission pulses with one intake of gas mixture. The authors thank V. M. Nesterov for helpful discussions. Figure 1, table 1, references 2: 1 Russian, 1 Western.
[226-2415]

UDC 621.373.826.038.823

STABLE PULSED CO_2-LASER USING LG-22 LASER

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 3, May-Jun 83 (manuscript received 26 Apr 82) pp 162-163

STONIS, S. and SHIRMULIS, E., Institute of Physics, LiSSR Academy of Sciences, Vilnius

[Abstract] A pulsed CO_2-laser has been built using the gas-discharge tube of an LG-22 laser and the power supply of an LGI-50 laser as source of pumping current pulses. The repetition rate of laser emission pulses is set by the discharge excitation frequency and can be varied over the 10-100 Hz range. The resonator cavity is formed by a mirror with 100% reflection and a diffraction grating with 150 lines/mm in a Littrow configuration. A cell containing gaseous SF_6 is placed inside this cavity. In an experiment two light beam splitting BaF_2 plates, one behind the other in the path of the emitted beam, diverted one fraction of the light to an IKS-29 spectrophotometer for

analysis of its spectral characteristics and another fraction to a Ge+Au photoreceiver at 77 K for measurement of the time characteristics of emission pulses. The maximum pulse power at the 10P(24), 10P(26), 10P(28) emission lines of a CO_2 molecule reached 500, 250, 150 W respectively, with high stability and almost independent of the pulse repetition rate. Figures 2, table 1, references 6: 1 Russian, 5 Western.
[226-2415]

UDC 621.373.018.756:621.373.029.67

ARGON LASER WITH MODE LOCKING AND INTRACAVITY BEAM EXTRACTION

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 3, May-Jun 83 (manuscript received 8 Jan 82) pp 159-162

BAKINOVSKIY, K. N., VOROPAY, Ye. S., KOYAVA, V. T., SARZHEVSKIY, A. M. and SHARONOV, G. V., Scientific Research Institute of Application Problems in Physics, Belorussian State University, Minsk

[Abstract] A continuous-wave argon-ion laser has been built with mode locking and with pulsed intracavity beam extraction, the latter including frequency regulation. The control pulse is shaped by a high-voltage amplifier-limiter without spark dischargers. The beam is extracted by means of acoustooptical deflectors designed with standard components and featuring higher reliability than a three-mirror resonator as well as high-speed hookup of the selector to the extracavity electrooptical modulator. Mode locking is effected by a Littrow prism made of heavy flint glass with one refracting facet, losses thus being minimized without violating the conditions for Brewster-angle incidence during wavelength tuning. A (Y + 36°)-cut $LiNbO_3$ crystal serving as piezoelectric transducer has been welded onto one of the parallel facets of the prism by the heat-pressure welding process with Cu+In bonding layers. The system was tested with an LG-106M1 Ar^+-laser, the resonator cavity formed by the reflective coating of the modulator prism and a mirror (reflection coefficients 0.998 and 0.98, respectively, at the λ = 0.5 μm wavelength), operating at the base frequency of 55 MHz. The modulation frequency was tuned to the intermode beat frequencies by adjustment of the mirror position with a micrometer screw. Oscillograms of the radiation intensity inside the resonator and in the extracted beam were recorded during continuous operation and during mode locking for four fundamental wavelengths (476.5, 488, 496.5, 514.5 nm with power output 0.4, 3.0, 0.5, 2.4 mW correspondingly, at 100 kHz extraction frequency and 26 A pumping current). Measurements of the emission recovery time during pulse extraction of radiation indicate that it decreases with increasing discharge current in the active element, reaching its minimum level of 0.4 μs at 25 A, in both modes of laser operation. The authors thank O. V. Shakin and Yu. M. Mokrushin for building the acoustic modulator. Figures 3, references 10: 5 Russian, 5 Western.
[226-2415]

UDC 621.384.6

VACUUMIZED HIGH-VOLTAGE CURRENT INPUT LEAD FOR ELECTRON INJECTOR

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 3, May-Jun 83
(manuscript received 23 Jun 82) pp 137-140

MARTYNOV, V. F., ZVEREV, V. V., ZAV'YALOV, M. A., LISIN, V. N. and
GUSEV, S. I., All-Union Institute of Electrical Engineering

[Abstract] A vacuum-type 300 kV current input lead with built-in cathode heater has been developed for continuous-duty electron injectors. It consists of two IAKV-150-200U4 semicylindrical ultraporcelain insulators, two potential shields made of AD1M aluminum alloy, a steel cover and a bottom flange. A Textolite sleeve for a KPV-150 high-voltage cable passes through the center hole in the cover, where the cable is centered and sealed, to the bottom flange. Here the cable terminates in a pothead connected to the injector cathode. The two insulators are soldered together along their straight parallel edges, tightening of the locknut at the bottom flange relieves the tensile stresses along the joints by producing a compression. The cathode heater is a split toroidal high-voltage isolation transformer, its two halves mounted inside the porcelain cylinder coaxially around the cable tube under the cover and on the bottom flange respectively. The current lead was tested with an injector cathode made of lanthanum boride (LaB_6) in the shape of a pellet 11 mm in diameter. It was found to have an electrical strength adequate to withstand voltage pulses of 30-150 kV amplitude and 300 μs duration, with the cathode heated to 1600-1700°C. Figures 4, references 4 Russian.
[226-2415]

UDC 621.383.292

INSTRUMENT FOR ANALYZING SHAPE OF SCINTILLATION LIGHT PULSES FROM THIN SCINTILLATORS BY METHOD OF INDIVIDUAL PHOTON COUNT

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 3, May-Jun 83
(manuscript received 1 Feb 82) pp 49-51

GALUNOV, N. Z., GEN, N. S., KRISHTAL', Ye. Ye. and TSIRLIN, Yu. A.,
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[Abstract] A high-resolution high speed instrument has been developed for analyzing the shpae of scintillation light pulses from thin (less than 2 mm thick) organic scintillators by the method of individual photon count. It consists of a source of polarized light (Y^{90} + Sr^{90} isotope mixture) followed by a "stop" photomultiplier behind a filter and an attenuating diaphragm, and a Cherenkov radiator followed by a "start" photomultiplier. The scintillator specimen is placed between light source and Cherenkov radiator,

a black coating on the surface of the latter serves as light absorber and light insulation between "start" and "stop" components of the system. Each photomultiplier feeds a pulse shaper with compensation of amplitude dispersion and tracking threshold, the "stop" photomultiplier feeds also a single-channel amplitude analyzer which puts out monoelectron pulses. A coincidence circuit with inputs from this amplitude analyzer and from the "start" pulse shaper feeds a multichannel amplitude analyzer which receives another input from a comparator circuit between the two pulse shapers, from the "stop" pulse shaper through a delay line. The Cherenkov radiator is a cylinder made of polymethyl methacrylate without scintillating additives, terminating on the output side in a polished conical horn as light guide. The instrument was used for analyzing the shape of pulses from binary and ternary composite polymer-film scintillators on polystyrene base with various additives: paraterphenyl; 1,4-bis[2-(5-phenyloxazolyl)]-benzene, 4,4'-distyryl diphenyl. For an evaluation of the data, the experimental curves were approximated with appropriate exponential time functions and fitting parameeers. Figures 3, table 1, references 6: 3 Russian, 3 Western.
[226-2415]

UDC 621.384.6

ION-OPTICAL STUDY OF ACCELERATION OF HEAVY IONS IN EGP-10-1 TANDEM GENERATOR

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 3, May-Jun 83 (manuscript received 19 Jul 82) pp 25-27

FRIEDRICH, M., Central Institute of Nuclear Research, GDR Academy of Sciences, Rossendorf

[Abstract] A study was made of acceleration of heavy ions in the EGP-10-1 electrostatic accelerator in Rossendorf (GDR), this accelerator having been built at the Scientific Research Institute of Electrophysical Apparatus in a MISS-4 minature cesium source by cathode sputtering. No difficulties were encountered in acceleration of atomic ions O^-, C^-, Br^-, I^-, F^- by electrostatic deflection plates, after their overcharge to $n \leq 7$ by a target, but the stability of the beam position was somewhat lower in the case of molecular ions CN^-, NH_2^-. For an analysis of the problem and pinpointing the causes of instability, trajectories of these ions in a high-energy accelerating tube were calculated and the results checked experimentally in an EGP-10-1 tandem generator. Dissociation of the two molecular ions into atomic ones, one of them N^{5+} in each case, was taken into account. The results, revealing a small deviation of trajectories from the accelerator axis inside and a small divergence at the accelerator exit, indicate the feasibility of efficient acceleration of all ions by an accelerator with properly matched low-energy and high-energy segments, with straight electrodes in the initial low-energy segment and with an oblique field in one high-energy segment. Figures 3, references 5: 2 Russian, 3 Western.
[226-2415]

UDC 621.384.6.01

QUANTUM-MECHANICAL ANALYSIS OF DEVICES FOR FOCUSING CHARGED-PARTICLE BEAMS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 3, May-Jun 83
(manuscript received 29 Jul 82) pp 22-25

SHENDEROVICH, A. M.

[Abstract] In many applications it is necessary to reduce the transverse dimensions of charged-particle beams, which requires focusing of wave packets of individual particles. This problem is explained and analyzed on the basis of a quantum-mechanical evaluation of focusing devices and their performance. For specificity, a quantum-mechanical wave packet is considered to be moving through a quadrupole magnetic lens. The vector potential $A_x = A_y = 0$, $A_z = 2|dH_y/dx|(y^2 - x^2)$ is inserted into the Klein-Gordon equation for a longitudinal momentum. The mean-square dimension of the wave packet with an initial Gaussian distribution is calculated from the solution to this equation. Devices for bidirectional focusing such as an x-focusing lens and a y-focusing lens following one another are then evaluated in the Wentzel-Kramers-Brillouin approximation, motion in the defocusing field being quasi-classical. Each of these lenses, while focusing a classical beam, will defocus a wave packet or leave it unchanged in the same direction when the rms dimension of the wave packet is, respectively, smaller than or equal to the dimension of the domain of the wave function which corresponds to the lowest energy level of the particle in the field of the lens. The conditions for obtaining a wave packet with transverse dimensions not exceeding a given limit are then established on this basis, whereupon the necessary field gradients and lens dimensions are calculated. A sectoral magnet with uniform field gradient is considered as a better device, capable of narrowing a wave packet to smaller atomic dimensions than does a pair of quadrupole lenses. The calculations and the results change when the wave packet is not a Gaussian one initially or when the wave function corresponds to a higher energy level of the particle in the field of the device. References 12: 6 Russian, 6 Western.
[226-2415]

UDC 517.9

MOTION OF CHARGED PARTICLES IN ELECTRIC FIELD

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 19, No 3, Mar 83
(manuscript received 13 Jun 80) pp 100-106

ZUBOV, V. I., Leningrad State University

[Abstract] Under consideration is the motion of charged particles in an electric field alone, without magnetic induction. This motion is described

by the system of differential equations $\dot{X} = Y$, $(m\dot{Y}) = E + C$ with the vector function $C = C(X,Y)$ equal to the sum of all forces other than those of the electric field acting on a particle. All functions appearing in these equations are assumed to be real, defined everywhere in space, and twice continuously differentiable. Eight theorems are stated and proved which define the conditions for steady motion of particles and formation of electron δ-beams. The first two theorems establish the condition for existence of an electric field generating a given velocity field $\dot{X} = \gamma(X)$ and causing a particle to move in accordance with the original equations. The third theorem establishes the conditions for existence of an initial-coordinates ($x_2 = 0$, $x_3 = 0$) manifold with conditional asymptotic Lyapunov stability. The next three theorems establish the necessary charge density and time delay distributions, assuming first an infinite and then finite velocity of interactions propagation. The last two theorems establish a new quantization rule of which the Bohr rule for the model of a hydrogen atom and the rule for any circular orbits are special cases. References 10 Russian.
[222-2415]

UDC 621.43.46

METHOD OF ENSURING PERFORMANCE OF OPTICAL INSTRUMENT FOR MEASURING TEMPERATURE OF BLADES IN HIGH-TEMPERATURE TURBINE

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 1, Jan-Mar 83 (manuscript received 3 Apr 82) pp 104-105

MERKULOV, A. P., VOLOV, V. T. and VILYAKIN, V. Ye.

[Abstract] Direct and continuous measurement of the temperature of blades in a gas-turbine operating at high temperatures is possible by the infrared method. The radiation receiver must be placed in the immediate vicinity of the blade array, which requires a cooling system for this receiver as well as for the output signal transducer and the electronic signal processing module. The use of a self-evacuating vortex tube for this purpose is proposed, with compressed air entering it through a triple-spiral impeller and leaving it through a diffuser with movable back wall for clearance regulation. The performance characteristic of such a tube is based on an approximately linear relation for the temperature drop across it, the maximum temperature drop being 140 K, with a stronger cooling effect at higher inlet temperatures. The temperature of the tube (normalized to the inlet temperature) is calculated according to an empirical relation, as quadratic function of the inlet pressure (normalized to the ambient pressure) and quadratic function of the normalized impeller area. Figures 2, references 4 Russian.
[245-2415]

UDC: 621.375.826:621.9.08

LASER SYSTEM FOR MEASUREMENT OF DEVIATIONS OF SHAPE AND LOCATION OF SURFACES

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 5, May 83 pp 27-30

KOKIN, Yu. N. and LEONOV, V. V.

[Abstract] The Sverdlovsk affiliate of the All-Union Scientific Research Institute of Metrology has developed a precision automated measurement system, the AIST-2, to test a combination of parameters of lathe and screw cutting machine beds. The system measures deviations from linearity and parallelism of prismatic and flat guide beds from 20to 20 m in length in the horizontal and vertical planes. The device utilizes the optical f-method of aplanometry with correction of the trajectory of the light beam in the air path of measurement. The light source used is an LG-78 helium-neon laser. The functional system of the device is diagrammed. The major functional elements are: a device for measurement of deviation from linearity; a device for measurement of deviation from parallelism; a measurement equipment rack for processing and recording of signals from the measurement devices. The limits of measurement of deviation from linearity and parallelism in the two planes are $\pm$0.8, $\pm$0.2, $\pm$0.1 and $\pm$0.05 mm. The scale of recording of deviations from linearity and parallelism is 125, 500, 1000 and 2000. The scale of recording of lengths of measured surfaces is 1:10, 1:30, 1:40, 1:120, 1:400 or 1:1200. The speed of movement of the carriage along the measured surface is 1.2 m/min. Figure 1, references 3 Russian.
[251-6508]

UDC 536.422.1

NONUNIFORM FRONT OF METAL SURFACE BREAKDOWN UNDER LASER RADIATION

Moscow POVERKHNOST': FIZIKA, KHIMIYA, MEKHANIKA in Russian No 5, May 83 (manuscript received 17 May 82) pp 15-22

VEYKO, V. P. and TUCHKOVA, Ye. A., Leningrad Institute of Precision Mechanics and Optics

[Abstract] The breakdown of a metal film surface under laser radiation is studied, the nonuniformity of the breakdown front being regarded as a result of nonuniform radiation density distribution over the surface. Two processes are involved, flow of molten metal and evaporation of the latter, their speeds being different in "hot" and "cold" spots of the surface. The evolution of a nonuniform breakdown front during a laser pulse of typically 10^{-8} - 10^{-7} s duration is analyzed on the basis of temperature distribution kinetics, assuming a negligible heat transfer to the substrate, and fluid flow hydrodynamics. The radiation flux density on the surface is assumed to have one component uniform over the surface and one component varying cosinusoidally with constant period and amplitude along one of the two rectangular coordinates in the plane of the surface, both components not varying in time. The temperature distribution is analogous in space, but its uniform component is a linear function of time and the amplitude of its alternating component is an exponential function of time. The rates of heating and evaporation depend on the thermophysical properties of the metal (density, specific heat, thermal conductivity and thermal diffusivity) as well as on the initial thickness of the film and on the components of the radiation flux density. The velocity field (two-dimensional) and the pressure field (one-dimensional) in the liquid metal film depend on its density and kinematic viscosity, the latter assumed to be low and flow assumed to be occurring within a plane boundary layer. The results of analysis based on the solution of corresponding equations indicate how the nonuniformity of the surface breakdown fronts depends on the combination of ratio of evaporation rate to flow velocity, amplitude of the alternating domponent of the radiation flux density, and initial thickness of the metal film. The time after the film begins to resolidify also begins to resolidify also depends on its thermophysical properties, which include its freezing (melting) point, as well as on its temperature at the end of the incident laser pulse. The authors thank M. N. Libenson and Ye. B. Yakovlev for discussion and helpful comments. Figures 5, references 8 Russian.
[228-2415]

UDC 629.735.33.015.3.023

BASE DRAG OF BODIES WITH CONICAL TAIL SEGMENT

Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA: MATEMATIKA, MEKHANIKA, ASTRONOMIYA in Russian Issue 2, No 2, Apr 83
(manuscript received 19 Nov 81) pp 46-49

BALANIN, B. A., MAKSIMOV, V. F. and ABROSIMOVA, T. Yu.

[Abstract] The base drag of bodies with conical tail segment in a supersonic gas stream was studied in a model experiment, with the Mach number of the oncoming stream varied over the N_M = 1.2-3 range. Measurements were made in a wind tunnel, with the Reynolds number in the open test zone within the $N_R = (1-3)\cdot 10^6$ range referred to the diameter of the model. The elongation of the conical tail segment was varied over the L/d = 0.3-1.5 range (d-diameter at midspan) and its taper angle was varied from 2 to 10°. The diameter at midspan of all models was d = 48 mm, with the cross-sectional area here equal to 10.24% of that of the nozzle throat. The results have yielded the pressure profile (static pressure at body surface normalized to the pressure in the unperturbed stream) along the generatrix of the conical tail segment, also the dependence of this static pressure as well as of the driving force at the base with a conical tail (normalized to the driving force at the base with a cylindrical tail) on the tail taper angle. The results reveal that in each case the driving force is maximum and, therefore, the drag force is minimum when the tail taper angle is α=6°. The drag force thus also depends on the elongation of the tail segment, Figures 3, references 5 Russian.
[231-2415]

UDC 532.526

SUSCEPTIBILITY OF BOUNDARY LAYER AT BODIES WITH BLUNT NOSE TIP TO ACOUSTIC VIBRATIONS OF STREAM

Novosibirsk IZVESTIYA SIBIRSKOGO OTDELENIYA AKADEMII NAUK SSSR: SERIYA TEKHNICHESKIKH NAUK in Russian Issue 2, No 8, Jun 83
(manuscript received 10 Oct 82) pp 47-51

DOVGAL', A. V. and KOZLOV, V. V., Institute of Theoretical and Applied Mechanics, Siberian Department, USSR Academy of Sciences, Novosibirsk

[Abstract] An experimental study was made of a boundary layer at a blunt body surface in an acoustic field of the oncoming stream. The two models for this experiment were cylinders 5.08 cm in diameter and 40 cm long with different nose tips. In the first model the nose tip was joined to the cylindrical segment through an elliptical transition segment (ratio of semiaxes 25:8.4). In the second model the nose tip was a hemisphere matching the base of the cylinder. Both models were tested in the T-324 low-turbulence

wind tunnel at the Institute, oriented with their axes of symmetry parallel to the stream. Acoustic vibrations in the stream were excited through a dynamic loudspeaker immersed within the diffuser zone of the tunnel. The frequency of sound was regulated by tuning the GZ-34 audio oscillator, its amplitude and spectral content were monitored with a PSI 202 pulse-type precision noise meter. The sound intensity (varied over the 80-111 dB range) in the boundary layer was measured with a dynamic microphone. The flow in the boundary layer was measured with a heat-loss anemometer. An evaluation of the results has yielded the distribution of static pressure over the model surface as well as the profiles of mean velocity and velocity perturbation intensity across the boundary layer. The data reveal two components of vibration, an acoustic one and an eddy-current one, the latter at sound frequency and the two producing amplitude beats when superposed. The amplitude of eddy-current vibrations was found to increase linearly with the sound pressure level in the test zone of the wind tunnel. The results indicate that already perturbations of small amplitude cause such a boundary layer to become unstable within the region of unfavorable pressure gradients and that Tollmin-Schlichting waves will propagate through the instability zone. Figures 6, references 14: 9 Russian, 5 Western.
[233-2415]

UDC 533.6.013.42

SOLUTION OF PROBLEMS OF DYNAMICS FOR NONCIRCULAR CYLINDRICAL SHELLS IN FLUID

Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR, SERIYA A: FIZIKO-MATEMATICHESKIYE I TEKHNICHESKIYE NAUKI in Russian No 5, May 83 (manuscript received 8 Apr 82) pp 28-32

VOROB'YEV, S. A.

[Abstract] The method of "boundary shape perturbations" is applied to the solution of problems of dynamics for noncircular cylindrical shells in a fluid. These problems are formulated for an infinitely long such cylinder in two systems of dimensionless coordinates: a circular cylindrical one, and a noncircularly curvilinear cylindrical one in which the equation for the cylinder boundary (lateral) surface becomes $\rho = 1$. A scalar function at the surface is transformed from the noncircularly curvilinear cylindrical system of coordinates to the circular one in accordance with the appropriate Jacobian. This concept is applied to vibrations of such a cylindrical shell under a harmonically varying load force in a boundless ideal fluid. The equation of motion is in the case treated as the boundary condition for the Helmholtz equation describing the pressure field and the deflection profile. The algorithm of the solution for an elliptical cylinder has been programmed on a BESM-6 high-speed computer. Figures 2, references 8 Russian.
[230-2415]

UDC 533.6.011.55

FLOW IN HYPERSONIC BOUNDARY LAYER AT DELTA WING OF FINITE LENGTH WITH NONZERO ANGLE OF ATTACK

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI
in Russian No 3, May-Jun 83 (manuscript received 14 May 82) pp 108-113

DUDIN, G. A., Moscow

[Abstract] The flow of a hypersonic stream of viscous gas past a delta wing of finite length is analyzed for the case of a nonzero angle of attack, assuming that the perturbation region consists of a nonviscous (in the first approximation) core and a viscous boundary layer. The nonviscous core is described according to the theory of small perturbations, the angle of attack α° remaining accordingly smaller than the characteristic dimensionless thickness of the boundary layer $\tau = (\tan\beta/N_R)^{1/4}$ (2β - vertex angle of the wing, N_R - Reynolds number referred to density and velocity in unperturbed stream, to wing length as characteristic dimension and to viscosity at stagnation temperature). The corresponding Navier-Stokes equations in the case of $N_R \to \infty$, and assuming a linear temperature dependence of viscosity, become equations of a three-dimensional boundary layer formulated here in Dorodnitsyn variables. These equations are further transformed through introduction of new varibales which appropriately account for the singularity of the flow function in the vicinity of the wing tip and for the attendant strong viscous interaction at the wing arms. The boundary-value problem for the resulting system of partial differential equations is solved numerically by the method of finite differences. As an example are shown the distributions of pressure and friction coefficient calculated for a wing with a 27° sweepback angle in an atmosphere of a gas with $\gamma = c_p/c_v = 1.4$ at a 0.3 rad angle of attack, using $\chi = N_M^2 N_R^{-1/2}$ ($N_M(\tau,\alpha^\circ) \geq 1$ Mach number in unperturbed stream) as the hypersonic interaction parameter. The results are compared with those for a zero angle of attack. In this case 300-400 iterations were required until the calculated pressure at the wing base had come close within 10^{-4} to its initially stipulated value. Figures 5, references 11: 7 Russian, 4 Western.
[229-2415]

UDC 533.6.01

GENERAL SOLUTION TO PROBLEM OF JET FLOW PAST WEDGE

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian No 3, May-Jun 83 (manuscript received 3 Mar 82) pp 98-103

TROSHIN, V. I., Vologda

[Abstract] An exact solution to the problem of a gas jet flowing past a wedge is obtained for the general nonaxisymmetric case of the wedge dividing the jet unequally. The corresponding equations are formulated in Chaplygin variables, assuming that stagnation occurs at the edge. The flow function and the complex potential are determined in Cartesian geometrical coordinates, with the lengths of the wedge faces to be generally unequal. Special cases are a flat plate (180° wedge opening angle), an infinitely long wall with a shapr bend, a gas jet striking parallel to the plane of symmetry, a boundless jet (stream) striking a wedge, and a jet of incompressible fluid striking a wedge, also combinations of these special cases. Figures 3, references 15: 14 Russian, 1 Western.
[229-2415]

UDC: 672.276.04

THEORETICAL STUDY OF EFFECT OF WAVE FLOW ON OBSTACLES

Baku IZVESTIYA AKADEMII NAUK AZERBAYDZHANSKOY SSR: SERIYA FIZIKO-TEKHNICHESKIKH I MATEMATICHESKIKH NAUK in Russian No 6, Jun 82 (manuscript received 18 Dec 81) pp 125-131

IBRAGIMOV, A. M., "Gipromorneftegaz" Scientific Research and Planning Institute

[Abstract] Strict theoretical solution of problems in the area of the flow around bodies by a stream with waves is very complex. A solution is presented to the problem using the characteristics of the wave flow based on the concept of potential wave theory. The solutions suggested yield additional information and can serve as a basis for calculation of wave loads on arbitrarily oriented obstacles in a shallow sea in the interval between 0.2 and 0.5 H/λ. References 8: 7 Russian, 1 Western.
[242-6508]

UDC 534-14

OSCILLATIONS OF FREE SURFACE OF LIQUID IN LONGITUDINALLY VIBRATING CYLINDRICAL VESSEL

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 19, No 3, Mar 83
(manuscript received 10 Dec 81) pp 71-76

KUZ'MA, V. M. and KHOLOPOVA, V. V., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] Longitudinal perturbations of a cylindrical vessel containing an ideal incompressible fluid are considered, these perturbations causing the vessel to vibrate and the free surface of the liquid to oscillate. General equations of motion for both vessel and liquid are formulated on the basis of the Ostrogradskiy-Hamilton principle. The amplitude-frequency characteristic of these oscillations are calculated assuming first harmonic and then random perturbations of the vessel. Resonance conditions and a stability region are found to exist in both cases, analogous in principle but depending on different parametric relations. In the case of random perturbations the amplitude of vibrations is assumed to be a twice differentiable function of time and its dispersion to be one order of magnitude larger than in the case of harmonic perturbations, a rational basis for comparative analysis. Figures 3, references 3 Russian.
[222-2415]

UDC 539.3

OSCILLATIONS OF CIRCULAR CYLINDER IN STREAM OF VISCOUS COMPRESSIBLE FLUID

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 19, No 3, Mar 83
(manuscript received 11 Jan 81) pp 50-59

GUZ', A. N., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] Small oscillations of a perfectly solid infinitely long cylinder with circular cross section in a uniform stream of a viscous compressible fluid are analyzed for such a cylinder with its axis perpendicular to the velocity of the unperturbed stream. That velocity is assumed to be constant at infinity, the fluid is treated as an elastic (barotropic) one, and effects of heat conduction are disregarded. The problem is formulated in dimensionless variables with the cylinder radius as characteristic dimension, in a Cartesian system of coordinates and a circular cylindrical one. The corresponding equations are linearized, with retention of the inertia terms. The components of the velocity vector and those of the stress vector as well as the pressure and the density are determined from the scalar potentials and the stress tensor. The problem is split into two separate ones, the steady-state problem for a stationary cylinder and the transient-state (dynamic) problem. The latter is any one of the four simpler problems to

which it has been reduced: 1) plane problem for translatory motion in the direction of the stream velocity; 2) plane problem for translatory motion perpendicular to both stream velocity and cylinder axis; 3) antiplane problem for translatory motion perpendicular to stream velocity and parallel to cylinder axis; 4) problem of rotation about the cylinder axis. All problems, the static one and each dynamic one with correspondingly different boundary conditions, are solved by the method of a small parameter. As a special case of the dynamic problem are considered harmonic oscillations along the cylinder axis. References 12: 9 Russian, 3 Western.
[222-2415]

UDC 621.438-253.5:536.242

EFFECT OF ROTATION ON HEAT TRANSFER IN RADIAL SLOT CHANNEL OF TURBINE BLADE

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 1, Jan-Mar 83 (manuscript received 11 Nov 80) pp 97-99

ISKAKOV, K. M. and TRUSHIN, V. A.

[Abstract] An experimental study was made of heat transfer in a rotating slot channel of a turbine blade with centrifugal air flow, this channel being formed by two half-blades soldered together. The speed of the channel was varied from 0 to 5500 rpm, corresponding to peripheral velocities up to 92 m/s. The heat transfer coefficients were determined according to a method earlier developed by the authors. The experimental data were then evaluated in terms of the ratio $\varepsilon = Nu_{rot}/Nu_{sta}$ of Nusselt numbers with the channel rotating and stationary respectively. The results indicate that the effect of rotation is already appreciable at low values of the Reynolds number and increases with increasing channel speed, also increases with increasing depth into the channel from the inlet side. The results indicate an analogy with air flow through a stationary curvilinear channel with rectangular cross section and with fins along the axis. Their theoretical interpretation on the basis of this analogy extends to inclusion of the Coriolos force with its effect on the velocity head and the pressure head. Calculations for a single air particle under random perturbations, with the aid of series expansions and with retention of first-order terms only, confirm the possibility of Taylor-Hertler vortices forming on the inlet side. On the basis of this analysis, the results are also generalized in terms of the number $S = \omega d_h/W$ (ω- angular velocity of air particle about the axis of rotation of the channel, d_h- hydraulic diameter of the channel, W- velocity of air stream).
Figures 4, referen es 9 Russian.
[245-2415]

UDC 621.438-226:536.24

EFFECT OF SUPERCRITICAL PRESSURE DROPS ON HEAT TRANSFER IN TURBINE NOZZLE ARRAYS

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 1, Jan-Mar 83 (manuscript received 24 May 82) pp 70-74)

BODUNOV, M. N., IVAN'SHIN, Yu. I. and LOKAY, V. I.

[Abstract] A systematic experimental study of heat transfer from gas to blades in high-temperature gas-turbine and turbofan engines with either transonic or supersonic gas velocities at the exit from the nozzle array has been made at the Kazan Institute of Aviation in a test stand allowing the Mach number M_{1t} as well as the Reynolds number Re_{1t} to be varied. The experimental data have then been generalized according to the similarity principle, in terms of the dimensionless complex $K_M = 0.5(k - 1)M_{1t}^2$ (k- adiabatic exponent) and the correction $\varepsilon_M = (\overline{Nu}_{M>1})/\overline{Nu}_{M<1})_{Re_{1t}} = idem = f(K_M) = A_0 + A_1K_M + A_2K_M^2$ ($\overline{Nu}_{M>1}$, $\overline{Nu}_{M<1}$ mean integral Nusselt number at respectively supercritical and subcritical pressure drop with $(Re_{1t})_{M<1} = (Re_{1t})_{M>1}$). The results of this evaluation reveal that in the subcritical range the mode of heat transfer along all characteristic segments of the blade profile does not depend on K_M up to $K_M \approx 0.16$ ($M_{1t} \approx 0.9$). Above this range the heat transfer depends appreciably on K_M, diminishing fast as K_M increases to $K_M \approx 0.32$ ($M_{t1} \approx 1.27$). Above this level the heat transfer first stabilizes and then begins to intensify again, but remains less intense than in the subsonic range. This trend is qualitatively the same throughout the blade profile but quantitatively different at different segments of it. Figures 4, table 1, references 8 Russian.
[245-2415]

UDC 532.517.4

MODELING PROCESSES OF TURBULENT TRANSFER IN SUPERSONIC BOUNDARY LAYER

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 1, Jan-Mar 83 (manuscript received 30 Nov 82) pp 59-63

SHISHOV, Ye. V. and YUGOV, V. P.

[Abstract] A model of turbulence is constructed for analysis of transfer processes in a supersonic nonisothermal compressible boundary layer. Close agreement between theoretical and experimental data on the temperature profiles and the stagnation temperature is attained by not assuming the same value of the Prandtl number over the entire cross section, but considering

that the heat transfer diminishes faster than the momentum transfer upon approaching the wall. Another partial differential equation of turbulent heat transfer closes the system of equations, not Pr = const, with the integral turbulence scale approximating and replacing the dissipation term. The ratio of dissipative velocity scale to dissipative temperature scale is assumed to be proportional to the molecular Prandtl number. Allowance is also made for an increase of the coefficient in this term from a nearly constant lower value for turbulent flow toward a higher value as the Reynolds number decreases through the transition range. This coefficient is determined from the known characteristics of a constant-stress turbulent boundary layer and refinement of the algorithm for an incompressible turbulent layer. The resulting "e - ε" model is finally supplemented with the equation of heat balance and the equation of state for an ideal gas, taking into account the temperature dependence of specific heat, dynamic viscosity, and thermal conductivity. Density (ρ) fluctuations are assumed to be small and appear with velocity (v) in all equations in the form of $\overline{\rho' v'}$ correlation as an extra term added to ρv. The system of equations was solved for a typical set of boundary conditions, with velocity and temperature profiles stipulated as initial conditions, on the basis of Prandtl's "mixing length" hypothesis. Figures 3, references 12: 4 Russian, 8 Western.
[245-2415]

UDC 629.036.001

CRITERIAL APPROACH TO ESTIMATING BUILDUP OF MASS AND ENERGY OF WORKING MEDIUM IN GAS-AIR DUCT SPACES OF GAS-TURBINE ENGINE FOR CALCULATION OF TRANSIENT OPERATING MODES

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 1, Jan-Mar 83 (manuscript received 14 Apr 82) pp 7-11

AKSEL'ROD, S. Ye. and KOFMAN, V. M.

[Abstract] Generalized relations are established for simulation and analysis of transient processes in a gas-turbine engine more accurate than on the basis of a quasi-steady model, specifically associated with the buildup of mass and energy of the working medium in the air-gas duct (combustion chamber and jet nozzle). Allowing for this buildup implies stipulating a lower gas temperature at the turbine inlet and a lower gas pressure in the combustion chamber. These relations for mass and energy as functions of time are derived from the differential equations of motion, continuity, and state for an ideal gas. These equations are written in a form applicable to all geometrically similar engines at analogous instants of time within the transient period, assuming identical initial conditions and the same mode of fuel admission. As a result, with the adiabatic exponent k = idem and the Mach number at the turbine inlet M_{Ma} = idem, two dimensionless complexes K_M and K_E are obtained which constitute the similitude criteria for mass and energy respectively. Calculations based on numerical data reveal that K_M = 0.003 and K_E = 0.004 are threshold values of these numbers below which accounting for the buildup does not significantly alter the results based on the quasi-steady model. Figures 2, references 3 Russian.
[245-2415]

UDC 539.3

PROPAGATION OF FLEXURAL WAVES IN NONCIRCULAR CYLINDERS WITH INITIAL STRESSES

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 270, No 6, Jun 83 (manuscript received 29 Jun 82) pp 1343-1345

GUZ', A. N., academician, Institute of Mechanics, UkSSR Academy of Sciences, Kiev, and MUSAYEV, Dz. A., Institute of Mathematics and Mechanics, AzSSR Academy of Sciences, Baku

[Abstract] The propagation of flexural waves in a compressible and transversely isotropic solid cylinder with noncircular cross section and arbitrary elasticity potential under an axial load is analyzed on the basis of the three-dimensional linearized theory of elasticity for finite initial strains. The cylinder is assumed to be infinitely long and have two axes of symmetry, one of them coinciding with the axis of isotropy. The problem is solved by the variational method, the conditions for existence of nontrivial solutions yielding the dispersion equation in determinant form. The phase velocity of flexural waves can be calculated from this equation for the general or any special case. References 6 Russian.
[232-2415]

UDC 621.6:534.1

NONAXISYMMETRIC NATURAL VIBRATIONS OF COMPOUND SHELLS OF REVOLUTION CONTAINING LIQUID

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 5, May 83 (manuscript received 14 Jul 82) pp 30-34

GRIBKOV, V. A., candidate of technical sciences

[Abstract] Nonaxisymmetric natural vibrations of compound isotropic shells of revolution were determined both experimentally and theoretically. The test model was a conical shell on a flat base plate, both made of high-grade 20 rolled strip steel. The shell had been formed with a single straight welding

seam from top (smaller radius 100 mm) to bottom (larger radius 250 mm) and joined to the base plate with a circular welding seam at the bottom. The structure could be classified as a thin one, the ratio of wall thickness to radius being 0.04 for the base plate and 0.0474 for the shell at bottom. Vibrations were excited in the test stand by a special-purpose contactless polarized electromagnetic vibrator of a shell-type construction. Miniature transducers were used for measurements, KV-10 devices weighing only 5 g each attached by means of adhesive wax, so as to minimize their effect on shell vibrations. Tests were performed with model freely resting on four symmetrically spaced spring supports. The shell was tested "dry" and containing water, altogether 14 vibration modes having been recorded and their frequencies measured. Theoretical calculations of the vibration frequency as function of the circumferential wave periodicity (order of mode) agree with the experimental data within 1% for the "dry" shell (n = 9) and within 12% for the shell with water (n = 12). Figures 3, references 4 Russian.
[237-2415]

UDC 534.001

MATHEMATICAL MODELS OF RIGID ROTOR MOUNTED IN NONLINEAR ELASTIC ROLLING BEARINGS

Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA: MATEMATIKA, MEKHANIKA, ASTRONOMIYA in Russian Issue 2, No 7, Apr 83
(manuscript received 28 Oct 82) pp 49-53

KEL'ZON, A. S.

[Abstract] The problem of plane rotation of a rigid rotor mounted in nonlinear elastic rolling bearings is an important problem in machine and instrument deisgn for long bearing life. The life of rolling bearings, used now in at least 95% of all rotating devices, drops sharply with increasing speed. This problem can be solved either by better balancing of the rotor and mounting the bearings in the stator housing through elastic retainers or by mounting them in retainers with a stiffness designed to put the operating speeds of the rotor within the self-centering range above the second critical. Here both methods are evaluated on the basis of corresponding two models of rotor dynamics in a plane, assuming that also forward precession takes place. One model is that of a balanced rotor and one model is that of a rotor with eccentric. The stability conditions are derived for each from three differential equations of motion: radial and transverse motion of the center of mass, and rotation about the axis through the center of inertia. The theoretical results as well as experimental results indicate that a higher precision of rotor balancing does not improve the bearing performance, while insertion of elastic retainers with properly matched stiffness does. The second method, already used in the U.S. and in Japan, is recommended for rotors operating at nominal speeds as high as 120-180,000 rpm. Figure 1, references 10: 9 Russian, 1 Western.
[231-2415]

UDC 539.3:534.1

NONAXISYMMETRIC HIGH-FREQUENCY VIBRATIONS OF ELASTIC DISKS

Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR, SERIYA A: FIZIKO-MATEMATICHESKIYE I TEKHNICHESKIYE NAUKI in Russian No 5, May 83
(manuscript received 13 May 82) pp 35-38

MELESHKO, V. V., Institute of Mechanics, UkSSR Academy of Sciences

[Abstract] Nonaxisymmetric high-frequency vibrations of circular elastic disks are analyzed on the basis of the exact solution to the three-dimensional problem in the theory of elasticity, without the simplifying hypothesis of a plane stressed state. The spectrum of natural frequencies is determined accordingly and the steady-state forced vibrations of such a disk under a load on its lateral surface are calculated, assuming the load to be symmetric with respect to the normal axis of the disk. The components of the displacement vector are expressed in dimensionless analytical form, normalized to the disk radius, and so as to satisfy the Lamé equations of motion. Satisfying the boundary conditions leads to an infinite system of linear algebraic equations, which is reducible to a finite one. The disk material is characterized by its shear modulus and Poisson ratio as well as the velocities of longitudinal and transverse waves in it. The solution is sought in Dini and Fourier series. Results obtained for the frequency range $\Omega<\Omega^* = 1.84$, where only a "longitudinal" mode and a "torsional" mode coexist with circumferential modes, reveal an approximately hyperbolic dependence of natural frequencies on the ratio of disk radius to disk thickness, with a plateau within the $\Omega\approx1.51$ frequency band. The wave numbers of those two modes do not depend on the order of the circumferential mode and can be determined from the Rayleigh-Lamb equations and from the SH-mode respectively. The curvature of the hyperbolas depends on the relative strength of two modes propagating in an infinitely large layer and their role in the resonance of a finite disk. Figures 2, references 7: 3 Russian, 4 Western.
[230-2415]

UDC 624.04.073.001:534.614:535

EXPERIMENTAL DETERMINATION OF MODES AND FREQUENCIES OF NATURAL VIBRATIONS OF CANTILEVER PLATE BY METHOD OF HOLOGRAPHIC INTERFEROMETRY

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 7, Jul 83 (manuscript received 8 Feb 83) pp 21-24

SMIRNOV, V. A., doctor of technical sciences, professor, and SHCHERBINA, K. B., candidate of technical sciences, docent

[Abstract] Holographic interferometry with time averaging was used in an experiment for determining the modes and frequencies of natural vibrations of

cantilever plates. The test objects were two rectangular plates made of an aluminum alloy with a Poisson ratio $\mu = 0.3$ and a modulus of elasticity $E = 70{,}000$ MPa. Both plates were 1.684 mm thick, 100 mm wide and 150 mm high, mounted vertically with rigid clamping at the lower edge: one freely and one with an additional support at a point on the left-hand vertical edge at 1/3 height. Vibration of the plate was excited by an a.c. electromagnet with smooth variation of the current frequency over the 25 Hz - 10 kHz range, a disk of magnetic steel 4 mm in diameter and weighing 4 g having been solidly attached to the aluminum object so as to leave an air gap in the magnetic circuit 0.2 mm wide at standstill. Holograms were recorded during passage through resonance and reconstructed in a scattered laser beam, interference fringes appearing as a result of deformation (differences of path lengths for light rays) and being brightest at nodal points on the plate surface. This method yields fringes the number of which, in the case of dynamic loads, does not depend on the vibration amplitude at any point. The method is highly accurate and excellent for visualization. Figure 1, references 3 Russian.
[235-2415]

UDC 539.4

STRESSED-STRAINED STATE OF MULTILAYER STRUCTURES UNDER PULSE LOAD

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 7, Jul 83 (manuscript received 17 Jun 81) pp 13-17

SIZOV, V. P., and SHUMARIN, S. I., candidates of technical sciences

[Abstract] The behavior of a multilayer structure under a loading pulse of short duration and high energy concentration is analyzed, for the purpose of evaluating the performance of composite materials under such conditions. The equation of motion for material particles, the same equation for each layer, is formulated in vector form with boundary conditions corresponding to "glued" joints between layers. Both the displacement field and the stress field are then expressed through vector and scalar potentials. The problem is solved by the matrix method with a wave matrix for each layer. For illustration, the procedure is applied to a plane pressure wave impinging on a symmetric sandwich structure in a rectangular system of coordinates. The solution is obtained, with the aid of Fourier transformations, in the form of superposed harmonic waves. On the basis of this solution has been established the dependence of the maximum tensile or compressive stress (normalized to the amplitude of the pressure wave) on the pulse repetition period (normalized to the pulse duration) and on the material of the outer layers (characterized by their wave impedance relative to that of the inner layer). The maximum stress is found to be a nonmonotonic function of the normalized pulse repetition period, with a sequence of sharp peaks whose height decreases with increasing ratio of pulse repetition period to pulse duration. Figures 3, references 4 Russian.
[235-2415]

UDC 624.07:534.1

VIBRATIONS OF NONLINEAR BEAMS WITH INTERNAL RESONANCES

Moscow MASHINOVEDENIYE in Russian No 4, Jul-Aug 83
(manuscript received 13 Jan 82, after completion 19 Jul 82) pp 18-24

MILOSERDOVA, I. V. and POTAPOV, A. I., Gorkiy

[Abstract] The problem of longitudinal vibrations is solved for a nonlinear cylindrical beam with internal resonances and with rigid constraints at both ends. The fundamental equations of longitudinal oppositely traveling waves, in a beam made of homogeneous material with nonlinear elasticity and inertia in the radial direction, are converted to homogeneous equations of coupled normal waves. This simplifies the calculations by reducing the problem to a symmetric one and is done in two steps. First steady nonlinear periodic waves describable by the Duffing equations are considered on each dispersion branch, then quasi-steady waves interacting with each other upon their encounter are considered. The general theory is, for illustration, applied to nonlinear vibrations of a ferrite core. Results for a bar of MK-16 ferrite (nonlinearity factor $\alpha=-0.02$ and dispersion factor $\beta=2.5\cdot10^{-5}$) used as radiator in ultrasonic devices are compared with those for such a bar of a hypothetical ferrite material "stiffly" nonlinear having the same parameters but a positive nonlinearity factor. Amplitudes and velocities of periodic waves and solitons are calculated for both. Figures 3, references 12 Russian. [234-2415]

UDC 539.3

MOTION OF ROTATING RIGID BODY ALONG CYLINDER RETAINED BY ELASTIC YOKE

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 6, Jun 83 (manuscript received 27 Jan 82) pp 18-22

POZHUYEV, V. I., candidate of technical sciences, docent

[Abstract] The objects of this study are a thick-walled hollow cylinder bonded to a thin elastic retainer around its outside surface and a rigid disk with a diameter equal to the bore diameter moving along the inside surface of the cylinder at constart velocity while rotating about its own axis. The disk imparts to the cylinder either axisymmetric tangential displacements or an axisymmetric torsion load. The state of stress and strain of such a cylinder under given boundary conditions is determined for both cases. Both problems reduce to two equations in a system of corrdinates moving with the disk, one an equation of motion for a medium transmitting shear waves only and one an equation of twisting motion for a shell, the two equations being solved by simultaneous integration with the aid of Fourier transformation with respect to the axial coordinate. Most interesting

from a practical standpoint is the case of a disk velocity lower than the velocity of shear waves in the medium. The boundary conditions for the two problems are circumferential displacement and circumferential stress, respectively, both functions of the axial coordinate on the inner surface and uniform on the outer surface of the cylinder. Both problems have been solved generally and for special cases such as a cylinder without retaining yoke and an infinitely thick cylinder (cavity in elastic space). Figures 2, references 2: 1 Russian, 1 Western.
[236-2415]

UDC: 539.3

TWISTING WAVES IN CYLINDRICAL SHELL WITH VISCOUS INCOMPRESSIBLE FLUID

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 19, No 4, Apr 83
(manuscript received 22 Oct 82) pp 117-121

SHCHURUK, G. I., Institute of Mechanics, Ukrainian Academy of Sciences, Kiev

[Abstract] Previous works on hydroelasticity for ideal fluids have not studied high frequency wave processes in thickwall shells or shells of composite materials with little shear rigidity. This article studies the propagation of torsional waves in orthotropic cylindrical shell filled with a viscous compressible fluid. The general solutions of the linearized Navier-Stokes equations for a viscous compressible fluid at rest are used. The movement of the orthotropic shell is described using equations produced by applying Timoshenko's hypothesis. In experimental studies, the influence of the viscous fluid (glycerine) led to a decrease in phase velocity, more so than water. The first mode of the torsional wave for the shell-viscous fluid system is dispersed in contrast to the wave in an empty shell.
[241-6508]

UDC: 539.3/4.013

PERIODIC AND DOUBLE PERIODIC SOLUTIONS OF EQUATIONS FROM TECHNICAL ELASTIC CYLINDRICAL SHELL THEORY

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 19, No 4, Apr 83
(manuscript received 6 Jan 81) pp 45-53

GOLOVCHAN, V. T., Institute of Superhard Materials, Ukrainian Academy of Sciences, Kiev

[Abstract] Systems of periodic and double periodic solutions are produced for equations from the technical theory of an elastic cylindrical shell.

The solutions can be used to analyze the boundary-value problems when studying the stress-strain state of thin circular cylindrical shells weakened by one or more apertures. A full system of solutions to the equations periodic with respect to x is presented. The system can be used to solve boundary value periodic problems both for a closed shell and for a cylindrical panel with one or more infinite rows of circular apertures with centers on straight lines parallel to the axis. As an example of an application of the theory, a study is made of the boundary value problem of longitudinal extension of a perforated cylindrical shell assuming that the contours of the circular apertures are free of external loads. Figure 1, references 4 Russian.
[241-6508]

UDC: 539.3

SOLUTION OF THE PROBLEM OF BENDING OF LAYERED INHOMOGENEOUS HOLLOW CYLINDER

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 19, No 4, Apr 83
(manuscript received 25 Jan 82) pp 24-29

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[Abstract] An approach is suggested to the solution of the problem of bending of a circular hollow cylinder composed of orthotropic layers, the elastic characteristics of each of which are generally functions of the radial coordinate r. One end of the cylinder is fixed, the other is exposed to a load. For an N-layered cylinder, a system of N 6th order equations is derived. Results indicate that in the load bearing layers the axial stresses are significantly greater than the circumferential stresses. The axial stresses are tensile, the circumferential stresses are compressive. Radial displacements change through the thickness of the wall and decrease with increasing thickness of the middle layer. Figures 3, references 6: 5 Russian, 1 Western.
[241-6508]

UDC: 539.3

EXPERIMENTAL AND THEORETICAL STUDY OF ELASTIC-PLASTIC BULGING OF CYLINDRICAL SHELLS UPON AXIAL IMPACT

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 19, No 6, Jun 83
(manuscript received 9 Jan 81) pp 63-69

BAZHENOV, V. G. and LOMUNOV, V. K., Gor'kiy State University

[Abstract] An experimental and theoretical analysis is presented of the effects of complex loading and alternating elastic-plastic deformation in the problem of impact bulging of cylindrical shells. Cup shaped specimens made of D16T alloy were made on a lathe and studied on a vertical hammer installation in which the impacting mass could be accelerated to speeds on the order of 25 meters per second. Theoretical studies were performed using the method of numerical solution of axisymmetrical elastic-plastic deformation problems. Nine specimens were studied in the experimental portion of the work. The results indicate that the loading in the bulging area differs significantly through the thickness of the shell, particularly in the outermost fiber of the shell where, beginning with the moment of appearance of elastic unloading, the parameters μ_σ and μ_ε change almost in opposite directions. In spite of the complex nature of the loading process the integral parameters of the process such as bending and forces calculated in the theoretical portion of the study agree well with the experimental data. Figures 5, references 8 Russian.
[240-6508]

UDC: 539.3

NATURAL OSCILLATIONS OF A CYLINDRICAL SHELL REINFORCED BY A RIB

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 19, No 6, Jun 83
(manuscript received 14 Sep 82) pp 52-57

NOVICHKOV, Yu. N. and SAMARIN, N. V., Moscow Institute of Hydroreclamation

[Abstract] This work is dedicated to the search for an exact solution to the problem of natural oscillations of a cylindrical shell with a rib. A systematic study is presented of the frequencies and forms as a function of change in parameters and location of the rib. All types of deformations of the rib and eccentricity of its placement on the shell are considered. It is found that as eccentricity increases the minimum natural oscillating frequency also increases. Beginning at a certain value of n, the lowest tone corresponds to nodal form II of shell oscillations, and with increasing eccentricity this value of n decreases. Figures 4, references 6: 5 Russian, 1 Western.
[240-6508]

UDC: 539.3

DETERMINATION OF CRITICAL DYNAMIC AXIAL COMPRESSIVE STRESS FOR RIB REINFORCED MULTILAYER CYLINDRICAL SHELLS

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 19, No 6, Jun 83
(manuscript received 22 Mar 82) pp 47-51

AMIRO, I. Ya. and PROKOPENKO, N. Ya., Institute of Mechanics, Ukrainian Academy of Sciences, Kiev

[Abstract] A study is made of the thin closed cylindrical shell assembled at orthotropic layers with articulated edges subjected to axial compressive stress which varies over time. The shell is reinforced with longitudinal and circular ribs. The connection between ribs and shell assures equal bending and angles of rotation of the ribs with the corresponding deformations of the shell. It is assumed that stress applied to the ends of the shell instantly affects the entire shell. The critical time and corresponding critical stresses at which bends develop rapidly are determined. Figures 5, references 5 Russian.
[240-6508]

UDC: 539.3

AXISYMMETRICAL ELASTIC EQUILIBRIUM OF THREE LAYER TRANSVERSELY CORRUGATED TRANSVERSELY ISOTROPIC CYLINDER

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 19, No 6, Jun 83
(manuscript received 26 Jun 81) pp 39-46

MATYASH, Yu. I., Poltava Construction Engineering Institute

[Abstract] A solution is presented to a static boundary problem for a three layer transversely corrugated thick wall cylinder using the method of disturbance of boundary form. Figures 5, references 7: 6 Russian, 1 Western.
[240-6508]

UDC 539.3

NATURAL FREQUENCIES OF TRANSVERSE VIBRATIONS OF BEAMS WITH HOLES

Kiev PROBLEMY PROCHNOSTI in Russian No 6, Jun 83
(manuscript received 8 Jul 82) pp 94-98

PREOBRAZHENSKIY, I. N., State Committee on Science and Engineering, USSR Council of Ministers, Moscow, and SHASALIMOV, Zh. Sh., Institute of Mechanics and Earthquake-Proof Equipment, UzSSR Academy of Sciences, Tashkent

[Abstract] Transverse vibrations of a beam with K rectangular and J circular holes are analyzed, assuming that each hole has been cut out normally to the neutral surface of the beam. The material of the beam is assumed to be homogeneous, with the mass and the modulus of elasticity expressed in terms of the Heaviside function. The hypothesis of plane sections is assumed to be applicable and nine different sets of end constraints are considered (both ends free; one end fixed and the other end free, freely supported, fixed, or held floating; one and held floating and the other end free or freely supported; both ends held floating; both ends freely supported. The differential equation of motion $\frac{d^2M}{dx^2} = -m\frac{d^2w}{dx^2}$ is solved for the deflection function, the latter sought in the form $w = \sum_{m=1}^{\infty} w_m(x)\sin\omega_m t$ describing free vibrations.

The natural frequencies are calculated by the Bubnov-Galerkin method. The results are referred to those for a solid beam without holes, for a comparative evaluation of the effect of holes in terms of the dependence of the frequency decrement on the hole size and hole location. The calculations have been programmed in ALGOL for an M-222 digital computer so as to cover any number of holes in any configuration. Figures 3, tables 2, references 5 Russian.
[223-2415]

UDC 539.3

VARIATIONAL-DIFFERENCE METHOD OF CALCULATING CRITICAL LOADS FOR SHELLS OF REVOLUTION

Kiev PROBLEMY PROCHNOSTI in Russian No 6, Jun 83
(manuscript received 15 May 82) pp 55-57

BABICH, D. V. and MARTYNOVA, N. Ya., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] The stability problem is solved and critical loads are calculated for shells of revolution with variable thickness and elasticity, using the

variational-difference method with the Treffitz principle applied to the total energy in the perturbed state. The three-dimensional problem is reduced to a two-dimensional one through application of Timoshenko kinematic hypotheses. The functional of the variational equation is then approximated through discretization, using quadrature relations with central rectangles and finite-difference relations of sixth-order accuracy. The resulting system of finite-difference equations has a symmetric band structure of 31st order. The critical load corresponds to the minimum value of the external-load parameter for which this system of equations has a nontrivial solution and thus to the zero-crossover of its determinant. The algorithm of obtaining the solution by the Gauss elimination method has been programmed in ALGOL-60 for a BESM-6 high-speed computer. The procedure and typical numerical results are shown for rigidly clamped cylindrical and conical shells under hydrostatic pressure. Tables 4, references 7 Russian.
[223-2415]

UDC 620.1.08

METHOD OF MEASURING LARGE ELASTOPLASTIC STRAINS IN DYNAMICALLY LOADED PLATES AND SHELLS

Kiev PROBLEMY PROCHNOSTI in Russian No 6, Jun 83
(manuscript received 17 May 82) pp 32-38

ALPAIDZE, Z. G., Moscow, and LEPIKHIN, P. P., Kiev

[Abstract] An experimental method has been developed for measuring large strains in thin plates and shells under dynamic loads which do not distort the axial symmetry. The method involves hatching photography of several spots on the body surface, on a moving film, then calculating the Euler coordinates so as to determine the components of Green's strain tensor and the law of motion of those spots. Continuous tracks of the spots are recorded on the film when the latter moves in a plane perpendicular to that of the spots, these tracks being generally curvilinear (rectilinear when the spots are stationary or move parallel to the film). Calculation of the Euler coordinates and of the displacement vector is demonstrated on a diaphragm under impact, the necessary formulas being derived from the geometry of the deformation process and of the optical (photographing) apparatus. Only three terms of the Newton binomial expansion are retained and higher than second-degree terms in the derivatives are disregarded. The accuracy of calculations is estimated, taking into account the size of spots and the speed of their movement as well as the distances between them and the curvature of the surface. The accuracy of measurements depends on the illumination of spots and on the resolving power of the film. The overall accuracy of this method is high, the proc dure is simple, and the equipment is inexpensive. Figures 6, references 11: 8 Russian, 3 Western.
[223-2415]

UDC 621.438.001.5

VIBRATION DIAGNOSIS OF RUNNER BLADES IN GAS-TURBINE SETS

Kiev PROBLEMY PROCHNOSTI in Russian No 5, May 83
(manuscript received 4 Dec 81) pp 40-44

IGUMENTSEV, Ye. A., "Soyuzturbogaz" Scientific-Industrial Association

[Abstract] A quantitative relation is established between resonance stresses in turbine blades and torsional vibrations of the runner, both defined as stochastic quantities and assuming axisymmetric flexural vibrations of the blade array (all blades bending simultaneously and in the same direction). The statistical characteristics of the dynamic parameters are derived from the corresponding equations of forced vibrations, with the perturbation torques and the equivalent moments of inertia expressed in terms of the dynamicity factor as functions of the frequency and integrals characterizing natural modes of free vibrations. Resonance vibrations and maximum stresses in the fundamental flexural mode (blades) as well as the amplitude of the twist angle (runner) are evaluated accordingly, with the special algorithm for a multimass system applied to a two-mass system to which a multimass system is reducible. Results based on these analytical relations agree with results based on a computer experiment for the runner of the axial compressor in a GTK-10 set as well as with the results of field measurements made in GTK-10 and GTK-750-6 turbine-compressor sets. This agreement indicates the feasibility of diagnosing resonance frequencies and amplitudes of torsional vibrations by this method. Figures 2, table 1, references 10: 9 Russian, 1 Western.
[224-2415]

UDC 539.3

THERMAL STRESSES IN PLATE UNDER BILATERAL LASER TREATMENT

Kiev PROBLEMY PROCHNOSTI in Russian No 5, May 83
(manuscript received 7 Jun 82) pp 36-38

KOLYANO, Yu. M. and BERNAR, I. I., Institute of Application Problems in Mechanics and Mathematics, UkSSR Academy of Sciences, Lvov

[Abstract] The thermoelasticity problem is solved for an infinitely large plate of finite thickness heated on both sides by a Gaussian laser beam which moves across the surface at constant velocity along one of the two coordinate axes. The transient temperature field is calculated from the fundamental solution to the corresponding equation of heat conduction, with zero temperature as initial condition and with zero temperature as well as zero surface temperature gradients at infinity as boundary conditions. The thermal stresses in the plate are calculated next, from the fundamental solution to the corresponding quasi-static problem. The steady-state solution is obtained after a change from stationary to moving coordinates and with time approaching infinity. The results indicate that thermal stresses can be decreased by

increasing the radiation concentration factor and by increasing the scan velocity of the laser beam. Figures 2, references 4 Russian.
[224-2415]

UDC 621.165-226.2.001-5:539.373

RESIDUAL STRESSES IN BLADES OF LAST STAGE OF LOW-PRESSURE CYLINDER IN 500 MW TURBINE

Kiev PROBLEMY PROCHNOSTI in Russian No 5, May 83
(manuscript received 12 Jan 82) pp 32-35

SORKIN, L. S., All-Union Thermotechnical Institute, and UGOL'NIKOV, V. V., Kharkov Turbine Manufacturing Plant

[Abstract] A study was made of residual stresses in turbine blades caused by plastic deformation of the surface layer during mechanical treatment in the manufacturing process. New blades for the last stage of the low-pressure cylinder in a K-500-240 KhTG3 turbine were used for the purpose of this study, their cross-sectional dimensions having been precisely determined. These blades are made of 12Kh11VMNF steel, 1050 mm long and with maximum thickness of 19.9 mm at the root and 5.6 mm at the tip, and with a 77°40' twist. The material for the test samples was carefully conditioned with regard to chemical composition so as to ensure excellent mechanical properties. Surface layers were successively removed by sawing. The results of measurements with strain gauges are now correlated with theoretical calculations of residual surface stresses in twisted blades. These calculations are based on the B. F. Shorr formula for strain and the conditions of equilibrium between axial force, two bending moments, and one twisting moment on a cut blade part. The results indicate that these stresses are minimum at the root (20-70 MPa) and maximum at the tip (280 MPa), not exceeding 40-90 MPa across the thickness of a blade section. It is recommended that warping of large blades made of 12Kh11VMNF steel be prevented by tempering the blade blanks at 700-720°C prior to machining. Figures 2, references 7 Russian.
[224-2415]

UDC 536.24.021

FREE DEFORMATION OF LONG DOUBLE-LAYER NONHOMOGENEOUS CYLINDER DURING CONVECTIVE COOLING

Kiev PROBLEMY PROCHNOSTI in Russian No 5, May 83
(manuscript received 19 May 82) pp 19-21

BELOUSOV, V. Ya., Ivano-Frankovsk Institute of Petroleum and Gas

[Abstract] A solid double-layer circular cylinder is considered in a temperature field where the temperature is a function of the radial coordinate only and of time, with a stress-free surface and with an ideal mechanical contact between both layers. The materials of both layers are assumed to be homogeneous and isotropic, and to obey Hooke's law, the temperature dependence of their mechanical and thermophysical properties being disregarded. Stresses, strains, and radial displacements in both layers of such a cylinder during its cooling from some initial temperature to a constant ambient temperature are calculated from the solution to a system of six equations describing the equilibrium of stresses, the compatibility of strains, relations between strains and stresses, and relations between strains and displacements, with appropriate boundary condtiions. Considering constraints which do not allow axial displacements makes it permissible to assume a plane state of strain. Considering large ratios $H/R_2 \gg 1$ of cylinder height to outside radius makes it permissible to assume a plane state of stress. The results reveal that the differences between properties of the two materials produce time-independent (residual) stress components, just as plastic strains do in a single-layer homogeneous cylinder cooled from a very high temperature.
References 4 Russian.
[224-2415]

UDC 534.231

DEFORMATION OF SPHERICAL SHELLS UNDER WIND LOAD

Kiev PROBLEMY PROCHNOSTI in Russian No 5, May 83
(manuscript received 30 Mar 82) pp 17-19

KAPPOV, N. I. and YEMEL'YANENKO, V. V., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] The stressed-strained state of a deep spherical shell under a load normal to its surface and symmetric with respect to its axis, such as a wind load, is calculated according to the general theory of thin shells with the equations of equilibrium formulated in terms of Novozhilov auxiliary functions. The solution for a shell without polar hole, obtained through expansion in an infinite Fourier series ($m = 0,1,2,...\infty$) and reduced to finite ($i = 1,2,3$) in Legendre spherical functions of the first kind, is compared with solutions based on theories of stiff and soft shells. Numerical calculations for a 3/4-sphere dome rigidly clamped around its base demonstrate

that, with the elastic properties of the material known, the stressed-strained state of a soft shell as well as of a stiff shell can be correctly determined in this way, while the zero-moment theory will yield erroneous results. Figure 1, table 1, references 4 Russian.
[224-2415]

UDC 539.67:620.178

HYDRODYNAMIC DAMPING OF TORSIONAL VIBRATIONS OF SHAFT-PROPELLER SYSTEM

Kiev PROBLEMY PROCHNOSTI in Russian No 5, May 83
(manuscript received 15 Feb 83) pp 3-10

PISARENKO, G. S. and BEREGOVENKO, A. Yu., Institute of Strength Problems, UkSSR Academy of Sciences, Kiev

[Abstract] An important problem in dealing with torsional vibrations of shaft-propeller systems in ships is to predict resonance and to evaluate damping effects. Hysteresis losses in the material, one major source of damping, can already be accurately calculated by asymptotic methods of nonlinear mechanics, but no definitive reliable method for calculating other modes of energy dissipation such as those associated with structural or hydrodynamic damping is yet available. In the method proposed by G. S. Pisarenko all modes of energy dissipation are represented by equivalent hysteresis loops, with the area of each corresponding to the respective fraction of total energy loss referred to the amplitude of potential energy in the elastic component ("spring") of the system, per unit volume of its material cyclically deformed to a given strain or stress amplitude. This general concept is here applied to hydrodynamic damping of torsional vibrations. A marine shaft-propeller system is treated as consisting essentially of an elastic rod with a small mass and a disk with a large mass mounted axisymmetrically at one end. Forced torsional vibrations due to small periodic angular displacements of the shaft constraint at the other end are calculated on the basis of the conventional equation of motion, assuming that those angular displacements in a plane parallel to the plane of the disk are proportional to a small parameter and subject to hysteresis. The results of calculations indicate that the propeller (disk) provides a damping effect on both vibration amplitude and dynamic stresses. The dependence of the logarithmic decrement on the vibration frequency and on the propeller speed as well as on the velocity of the impinging water stream must and can be determined experimentally, as a basis for calculating the amplitude-frequency characteristic of the system. Inclusion of hydrodynamic damping in the design calculations yields a 2-5% more accurate estimate of resonance frequencies. Figures 6, references 10 Russian.
[224-2415]

UDC 634.07

NATURAL FLEXURAL VIBRATIONS OF THREE-DIMENSIONAL BEAM ARRAY

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 19, No 3, Mar 83
(manuscript received 27 Nov 80) pp 127-129

KHABLO, C. P., Kharkov Polytechnic Institute, Kremenchug branch

[Abstract] An array of six beams with identical characteristics (same length, mass per unit length, principal axial moment of inertia, modulus of elasticity of first kind) is considered, these beams extending in six directions in space from a common center body of mass M to which they are all rigidly joined at one end with the other end free. The differential equations of motion for this array are formulated in a stationary central Cartesian rectangular system of coordinates whose axes coincide with the principal axes of beam cross sections. This system of equations is solved for small free vibrations of the array. The results reveal several subspectra of different multiplicities within the overall spectrum of natural frequencies, the vibration modes of any individual beam element being orthogonal within each subspectrum but not orthogonal between different subspectra. Therefore, a classical expansion into modes is not possible here. The results can be applied to an artificial earth satellite, which such an array of beams closely simulates. Figures 2, references 2 Russian.
[222-2415]

UDC 539.3:534.1

OPTIMIZATION OF CIRCULAR CYLINDRICAL SHELL WITH GIVEN MASS SUBJECT TO STEPWISE LOADING BY AXISYMMETRIC EXTERNAL PRESSURE

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 19, No 3, Mar 83
(manuscript received 30 Jan 81) pp 117-120

RYABTSEV, V. A., Boronezh Polytechnic Institute

[Abstract] A circular cylindrical shell is optimized for maximum critical external pressure load as criterion functional. The longitudinally variable thickness as well as its derivative with respect to the longitudinal coordinate are bilaterally constrained, the mass of the shell is fixed, and the density of its material is assumed to be constant. The pressure, axisymmetrically distributed around the shell, is applied to a finite segment of the shell only. The critical state of equilibrium and the boundary conditions have been defined according to the semimoment theory of shells. The corresponding boundary-value eigenvalue problem for the system of differential equations in the general operator form $Bw-\lambda fw = 0$ ($i = 1,2,3,4$) describing it are solved numerically, after normalization of all variables and conversion to the finite-difference analog (w- deflection, B- differential operator) with the energy norm (Bw, w) for the function of w. Each matrix in the grid

is of the MxM dimension, M being the number of grid nodes including those along the boundaries. Results have been obtained for various ratios of length to radius and of radius to mean thickness, for shells hinge-supported or rigidly clamped at the edges, the criterion of optimality being the maximum ratio of critical pressure to that for a shell with uniform thickness. Figures 2, references 6 Russian.
[222-2415]

UDC 539.3

EFFECT OF INITIAL STRESSES ON 'BACKWARD WAVE' IN PRESTRESSED COMPRESSIBLE CYLINDER-FLUID SYSTEM

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 19, No 3, Mar 83
(manuscript received 10 Dec 81) pp 66-70

BAGNO, A. M., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] A hollow cylinder containing fluid is considered and the existence of a "backward" wave is demonstrated, such a wave being dependent on the initial state of stress. The solid material is assumed to be nonlinearly elastic with an elasticity potential of arbitrary form, and the fluid is assumed to be an ideal compressible one for analysis in the acoustic approximation. The corresponding equations of hydroelasticity with the wave equation are formulated in a cylindrical system of coordinates, on the basis of the three-dimensional linearized theory of finite elastic strains for the solid and the linearized Euler equations for the fluid, assuming an infinitely long cylinder of uniform wall thickness in a uniform state of initial strain. For small perturbations this system of equations reduces to one of four homogeneous linear algebraic ones. The condition for existence of a nontrivial solution to these yields a transcendental dispersion equation which describes the propagation of axisymmetric waves through a prestressed compressible hollow cylinder containing an ideal compressible fluid. A numerical solution requires that the elasticity potential of the cylinder material be stipulated, an elasticity potential defined in terms of three invariants such as the Murnahan potential describing the behavior of rigid materials. A numerical solution has been obtained on a computer by a rapidly converging iteration method for a cylinder made of 09G2S low-alloy steel with and without fluid. The results indicate that axial precompression causes the critical frequency to become higher and that "backward" waves appear in "thick" cylinders but not in "thin" ones. Figures 5, references 12: 9 Russian, 3 Western.
[222-2415]

UDC 539.3

TRANSIENT PROCESSES DURING INTERACTION OF ELASTIC SOLID OF REVOLUTION WITH FLUID

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 19, No 3, Mar 83
(manuscript received 18 Dec 81) pp 60-65

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[Abstract] The transient behavior of a reservoir or tank under a rapidly varying external load is analyzed, such a structure being treated as a hollow elastic solid body with an axisymmetric shape and containing an incompressible fluid. The equations of motion for a wave process under a load which varies both in time and space are formulated most generally in tensor and vector form, in three systems of corrdinates: a Cartesian system and two curvilinear systems fixed relative to the solid container and to the fluid respectively. The equation of pressure is derived from the solenoidality of the velocity field at every instant of time. The problem is solved by the method of finite differences, with the differential equations of motion for the elastic solid and the corresponding boundary conditions appropriately discretized. Space derivatives are approximated with central differences, and time derivatives are approximated with differences acoording to a 3-layer explicit scheme. The region of the fluid is covered with a difference grid of quadrilaterial elements. Symmetry and other geometrical characteristics of the solid-fluid system are taken into account. Initial conditions are stipulated for forces, displacements, and pressure in the fluid. Computer-aided calculations by the method of invariant immersion, with an appreciable saving of machine time, have yielded the transient characteristics of solid-fluid interaction in terms of displacements and pressure as functions of time. The results are compared with solutions to several test problems, one of them being the case of constant hydrostatic pressure of the fluid. Figures 4, references 7 Russian. [222-2415]

UDC 539.377

THERMAL STRESSES IN THIN SPHERICAL SHELL WITH CURVILINEAR HOLE

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 19, No 3, Mar 83
(manuscript received 5 Dec 80) pp 46-49

MATKOVSKIY, A. P., All-Union Scientific Research Institute of Measurement and Control Systems, Lvov

[Abstract] The problem of thermoelasticity is solved for a thin shallow spherical shell with a large curvilinear hole in a nonuniform temperature field. The thermal stresses and deflections in such a shell are calculated by the method of "boundary shape perturbations", assuming a free contour of the hole and the latter to be uniquely conformally mappable from its z-plane ($z = re^{i\theta}$) as a circular hole of unit radius onto the ζ-plane

($\zeta = \rho e^{i\theta}$) by the function $z = \omega(\zeta) = \zeta + \varepsilon f(\zeta)$, $f(\zeta) = \zeta^{-N}$. A solution is obtained for the case of a pressure distribution in the form of a double trigonometric series and mean temperatures corresponding to convectiveeheat transfer to the ambient medium. Numerical results for an elliptical hole (N = 1) are compared with those for holes in the form of regular polygons (triangle N = 2, square N = 3, pentagon N = 4, hexagon N = 5) with rounded corners. Figures 4, table 1, references 10 Russian.
[222-2415]

UDC 539.3

STABILITY OF TRIPLE-LAYER CYLINDRICAL SHELLS WITH DISCRETE FILLER UNDER AXIAL COMPRESSION

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 19, No 3, Mar 83
(manuscript received 30 Dec 81) pp 41-45

SEMENYUK, N. P. and ZHUKOVA, N. B., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] Triple-layer cylindrical shells are considered with the filler in the form of an array of stamped round studs joining the two carrier layers so as to prevent their slippage or separation under load. This array of studs constitutes, in effect, a filler layer with discrete distribution of elasticity and shear moduli under radial tension-compression when the shell is under axial compression. Such a distribution of moduli is represented as a product of two delta functions, each with respect to another coordinate. The buckling modes and the stability under compression are analyzed and the critical load is calculated by application of the variational principle to total and potential strain energy in terms of displacements. Typical numerical results for a uniform array of joining studs correlate with experimental data on double-layer cylindrical shells produced by spot welding. Figures 5, references 3 Russian.
[222-2415]

UDC 621.787.4.07

FORMATION OF REGULAR MICRORELIEF DURING CENTRIFUGAL-IMPACT TREATMENT OF SURFACES AND CALCULATION OF ITS PARAMETERS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian
No 5, May 83 (manuscript received 2 Jul 82) pp 135-139

SOROKIN, V. M., candidate of technical sciences, docent, and
MAGNITSKAYA, S. F., assistant

[Abstract] A technological process of centrifugal-impact treatment of surface has been developed which produces a regular surface microrelief, uniform hardening, and a high degree of cold working over the entire area. The tool is a rotating disk mounted on bearings with an array of radial nesting slots around the periphery into each of which a steel ball has been inserted. These balls are free to move along the slots without falling out and to freely spin about their axes. The centrifugal force pushes them to the open ends of the slots at the disk periphery, from where they protrude and impact on the treated surface of an also rotating blank part when brought sufficiently close. The mechanism of microrelief formation is based on the realtion between tool and blank speeds, a rectangular or hexagonal honeycomb microrelief pattern forming at definite speed ratios. The height of ridges and the depth of depressions depend on the geometrical configuration of disk and blank. An advantage of this process is that not only the microrelief parameters but also the physico-mechanical characteristics of the surface layer can be controlled, according to standard norms or special customer requirements. Figures 2, references 7 Russian.
[237-2415]

UDC 539.4

MODEL DESCRIBING EVOLUTION OF STRESSED-STRAINED STATE IN SPHERICAL FUEL ELEMENT

Novosibirsk IZVESTIYA SIBIRSKOGO OTDELENIYA AKADEMII NAUK SSSR: SERIYA TEKHNICHESKIKH NAUK Issue 2, No 8, Jun 83 (manuscript received 9 Apr 82) pp 15-19

LELEKOV, V. I., PETUKHOV, Yu. I. and FURSENKO, A. A., Institute of Thermophysics, Siberian Department, USSR Academy of Sciences, Novosibirsk

[Abstract] A mathematical model is constructed for describing the spherically symmetric state of stress and strain of a spherical fuel element with cavity at the center. The model is based on the physical one and the corresponding system of exact equations, rather than on the multizonal model which yields an incompatible system of equations here, and a numerical method of solution is proposed for determining the evolution of stresses and strains. Initial conditions are stipulated in terms of the radial profiles of radial and circumferential stress and strain components at time $t = 0$. Boundary conditions are stipulated in terms of the radial stress component being at any time $t \geq 0$ equal and opposite to the internal pressure of gas inside the cavity and to the external pressure of coolant around the surface respectively. The fuel layer is assumed to be rigidly fastened to the shell and creep of the shell material is described by a power-law relation. Both plastic and elastic strains are followed through the transient stage of the deformation process, assuming negligible volume changes with a linear creep rate at high temperatures and moderate stress levels under uniaxial tension. Dilation of the fuel layer due to formation of solid and gaseous nuclear-fission products is accounted for in terms of balancing hydrostatic pressure and in accordance with laws of combustion thermodynamics. Fuel layer dilation as function of the radial coordinate and circumferential shell strain as function of time have been calculated by this method with the use of a dimensionless space-time grid for typical initial conditions including creep strain equal to total strain at time $t = 0$. The authors thank L. V. Potaturkin for assisting with computer calcul. 'ons. Figures 3, references 10: 3 Russian, 7 Western.
[233-241]

UDC 621.91

WEAR RESISTANCE OF CUTTER CERAMICS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 6, Jun 83 (manuscript received 23 Jul 82) pp 139-142

AUKENOV, M. M., graduate student

[Abstract] Tool bits made of VOK60 and VZ ceramic materials from the "Dnepr" hard alloys production plant were tested for wear resistance during sliding

with friction and during cutting, in fabrication of pipe made of 24-44 gray cast iron (3.10/3.30% C, 2.03/1.96% Si, 0.66/0.67% Mn, 0.12/0.12% P, 0.15/0.11% S, 0.14/0.27 Ni, 0.17/0.17% Cr, Bhn 194-216/163-179 for sliding/cutting). The ceramic specimens for sliding with friction were 30 mm long 5x5 mm square bars conically tapered to a 1 mm diameter at one end. The ceramic specimens for cutting were 2010-0056 trihedral bits held together with a support plate of VK15 hard alloy and an attached chip breaker of VK8 hard alloy by 150 mm long 25x25 mm square bars. The VOK60 ceramic was tested without and with coolant-lubricant fluid, the latter found to reduce the wear resistance at cutting speeds above 1.25 m/s, the VZ ceramic was tested without coolant-lubricant fluid only. The results have been evaluated on the basis of the G. I. Gronovskiy equation accurately approximating the dependence of wear resistance on sliding or cutting velocity with the wear resistance peaking within the 1.25-10 m/s range ($W = aV^b e^{cV\frac{\gamma \cdot m}{mg}}$), constants a,b,c depending on the ceramic material and on presence or absence of coolant-lubricant fluid). The results reveal that the wear resistance decreases monotonically as the cutting speed increases, according to the empirical relation $V = 22.1/T^{0.33}$ m/s (T - stability period, min) for both ceramic materials at 1 mm cutting depth and 0.2 mm/rev feed rate without coolant-lubricant fluid. An x-ray spectral analysis under a "Stereoskan-180" electron microscope and x-ray energy dispersion analysis in a "Link-290" spectrometer revealed that the main ingredient of chips is iron. Wear was found to occur predominantly at the main back surface and only slightly in the form of worm holes at the auxiliary back surface, with very shallow lune holes forming at the front surface of the tool bit. Figures 3, tables 2.
[236-2415]

UDC 621.491

TREATMENT OF PARABOLIC METAL MIRRORS WITH SYNTHETIC SUPERHARD MATERIALS

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 6, Jun 83 (manuscript received 28 Jul 82) pp 45-46

GRITSEV, L. G.

[Abstract] A technology has been introduced for treatment of parabolic mirrors made of 12KhN3A steel (carburized to hardness 62-65 Rockwell C) with a knife-edge bit on the cutter made of synthetic superhard material (composites 09 PTNB and 10 Hexanite-P using boron nitride as base). Machining is done on a 16K25Psp lathe with a hydraulic pantograph taken from a 16K20 lathe, with a velocity V = 150 m/min and a cutting rate s = 0.01 mm/rev. An allowance of 0.5-0.75 mm of mirror material is required for cutting. The treatment produces a parabolic surface with deviation not exceeding 0.005-0.02 mm, also conical surfaces, a surface finish of not more than 0.09-0.14 μm roughness, and features minimal surface heating (temperature rise 35-45°C) so that the need for lubricant-coolant fluid to prevent burnishing and buildup of abrasive is eliminated. Figures 2.
[227-2415]

UDC 621.3.078

CALCULATION OF DAMPING COEFFICIENT FOR OSCILLATIONS OF SUPERCONDUCTING SPHERE IN ELECTROMAGNETIC FIELD

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE
in Russian Vol 26, No 6, Jun 83 (manuscript received 20 Oct 82) pp 72-76

YEFREMOV, A. F., Moscow

[Abstract] One problem in the design of electromagnetic suspension systems is damping the oscillations of the suspended body. Passive electromagnetic damping by means of a conducting ring has been proposed for oscillations of a superconducting sphere. Here a simple method of calculating the damping coefficient in such a system is proposed. It involves determining the current induced in the ring segments as well as the constant magnetic field produced by the magnet system and its force acting on the sphere. The problem is formulated in two spherical systems of corrdinates: one fixed concentrically with respect to the magnets and the dampers, one fixed concentrically with respect to the sphere so that the distance between the origins of both systems varies as a function of time. On account of the axial symmetry, the magnetic vector potential and the current density have each one component only. The magnetic vector potential is expanded in a series with respect to spherical Legendre functions, whereupon the magnetic induction and then the force are calculated from the solution to the corresponding Laplace equation, after transformation from the stationary system of coordinates to the oscillating one and with the shielding effect of the field in the conductor disregarded. Finally, the damping coefficient is obtained as the sum of a geometric progression in a form directly usable for design calculations and indicating its dependence on the electrical conductivity of the damper material, the dimensions of the damper system, the dimensions of the field winding, and the mass of the sphere. A numerical example demonstrates that aperiodic damping of linear oscillations in this case is feasible. Figures 2, references references 5 Russian.
[225-2415]

UDC 527.623

ERRORS IN TYING GEOPHYSICAL FIELDS BY ASTRONOMICAL METHODS

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE
in Russian Vol 26, No 6, Jun 83 (manuscript received 23 Nov 82) pp 60-63

YUSHCHENKO, V. I., Leningrad Institute of Precision Mechanics and Optics

[Abstract] Three concentric systems of coordinates are introduced for astronomical measurement of geophysical fields: 1) an equatorial one tied to a point in the Aries constellation and to the earth's axis of rotation; 2) a

horizontal one tied to the line joining the center of the earth to the center of mass of an object; 3) an objective or instrumental one tied to the structural axes of the object or the instrument, in which the geophysical (gravitational, magnetic) vector is measured. The position of systems 1 and 2 relative to one another is defined by stellar time, longitude and latitude. The position of systems 2 and 3 relative to one another is defined by yaw, roll and pitch angles. The position of two bright stars is defined in the equatorial system of coordinates. The problem is to tie the geophysical vector measured relative to thsee two stars in the instrumental or objective system of coordinates to the horizontal one, and then estimate the error of this tying. The problem is solved using a set of three basis vectors and a set of orientation matrices, the latter relating the vectors of the geophysical field in the different systems of coordinates. With the aid of Taylor series expansions and with the two stars located successively in four (two oblique and two rectangular) systems of coordinates variously defined by the basis vectors, the inaccuracy of tying is calculated as function of the errors in stellar time, longitude and latitude readings. The maximum possible effect of these errors is estimated by treating the four equations as an indeterminate system in one variable (typing error) with all reading errors as independent normally distributed random quantities. A solution is obtained by the method of least squares. As an example is estimated the effect of an error in reading the orientation of the gravitational vector and the magnetic vector relative to the earth's surface on the inaccuracy of tying these vectors. Figures 5, references 2 Russian.
[225-2415]

UDC 621.383.54+681.142

MULTICHANNEL INSTRUMENT FOR PRECISION MEASUREMENT OF RADIATION ENERGY EMITTED BY PULSE LASERS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 3, May-Jun 83 (manuscript received 28 Jan 81) pp 166-168

LARIKOV, A. V., MALYUTIN, A. A. and FILIPPOV, A. N., Institute of Physics, USSR Academy of Sciences, Moscow

[Abstract] An automatic multichannel instrument has been designed for precision measurement of the radiation energy in laser pulses of shorter than 10 ns duration. It consists of a bank of DKPs-25 surface-barrier recording detectors followed by passive integrators with K140UD1B microcircuit amplifiers, and an 8-channel 11-digit analog-to-digital converter (AD811 EG&G Co) in a CAMAC crate interfaced through a controller with the processor of a minicomputer (Nova 2/10 Data General Co). Tape punch and tape readout with teletyper are the input/output devices. Data are processed in BASIC language with built-in subroutines for access to the CAMAC in ASSEMBLER language. A photoreceiver cell contains, in addition to the detector, also a light scatterer and a set of neutral light filters. The detectors have been calibrated against an IMO-2 instrument with an LTI-5 laser (λ = 1.064 μm

wavelength) as radiation source in the Q-switched mode. Light pulses of constant combined energy were applied to a pair of detectors, the incident light beam being split by a Rochon polarization prism and the ratio of the two intensities varied from 0 to 1 by varying the tilt of a phase plate or by means of a Pockels shutter. The instrument characteristic is linear within 1% over the range of 128-2047 readouts with light pulses of 15 ns duration at the 1.064 μm wavelength. The precision with fewer than 128 readouts is determined by that of the analog-to-digital converter. The relative error of the instrument is within 1%, its absolute sensitivity is of the order of 10^{-8} J. For correct measurements it is necessary to eliminate interference in plane-parallel mirror substrates and to minimize the signal component due to light scattered by mirrors and other boundary surfaces, also the signal component due to detector bias produced by scattered laser and pump radiations. The authors thank S. D. Zakharov and M. A. Otlivanchik for assistance. Figures 4, references 4: 3 Russian, 1 Western.
[226-2415]

UDC 539.1.074.8:621.039.564.2

DEVICE FOR MONITORING FAST-NEUTRON FLUX DENSITY

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 3, May-Jun 83 (manuscript received 12 Nov 81) pp 31-33

ASTVATSUR'YAN, Ye. R., BARBASHOV, V. M., GODOVITSYN, V. M. and CHUMAKOV, A. I., Moscow Institute of Engineering Physics

[Abstract] A semiconductor-type detector of fast neutrons can monitor the neutron flux density during a process or experiment. Its operation is based on recording the electric charge produced by ionization of secondary particles during a single interaction between a neutron and atoms of the substance contained within the active volume of the sensing element. A reverse-biased p-n junction serves as the sensing element, which is followed by an amplifier stage and a counter. Such a device can be used for automatic performance on intricate experiments with immediate data processing. It has been incorporated in a monitor of the flux density of fast neutrons. Following a neutron-atom interaction, the detector generates an output voltage pulse at the collector. This pulse is preamplified, amplified, and shaped in a discrimination-threshold device before proceeding to a timer-controlled counter with digital readout. This monitor was used experimentally with an IRT-2000 research-engineering reactor for determining the profile of neutron flux intensity above a given energy threshold in the vertical channel of this reactor. Figures 3, references 4: 3 Russian, 1 Western.
[226-2415]

UDC: 531.717.7:389.14:006.065

AUTOMATED SYSTEM FOR HIGH PRECISION ANGLE MEASUREMENTS

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 5, May 83 pp 25-27

GLUKHOV, O. D., KUDIN, O. A., PRITSKER, V. I. and SVERDLICHENKO, V. D.

[Abstract] A new state plane angle standard has been created at the All-Union Scientific Research Institute for Metrology imeni D. I. Mendeleyev. One of its distinguishing features is a built-in system for complete automation of procedures for producing and using measurement information, diagnosis of the standard installation and control of the course of a measurement experiment. The system, called the "Radian" high precision automated measurement system, includes three main parts: an automatic measurement system, information-control system and software support system. The automatic measurement system is used to place the marks of two autocollimators on an image and measure the difference in displacement of these marks relative to the axes of the collimators, proportional to the angle between the faces of the prism. The principle of operation of the measurement channel is automatic adjustment of the center of the field of vision of a photoelectric convertor to the center of the image of the autocollimator mark. All elements of the measurement channel are based on type K284UD1A integrated microcircuits (operational amplifier with input field effect transistor). The use of the automated measurement system as a part of the standard significantly improves its technical and economic characteristics. The acceleration of the process of measurement, processing and documentation of results reduces the time required to certify a prism. Figures 2, references 2 Russian.
[251-6508]

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